

THE AMMONITE FAUNA OF THE CALCAIRE À *BACULITES* (UPPER MAASTRICHTIAN) OF THE COTENTIN PENINSULA (MANCHE, FRANCE)

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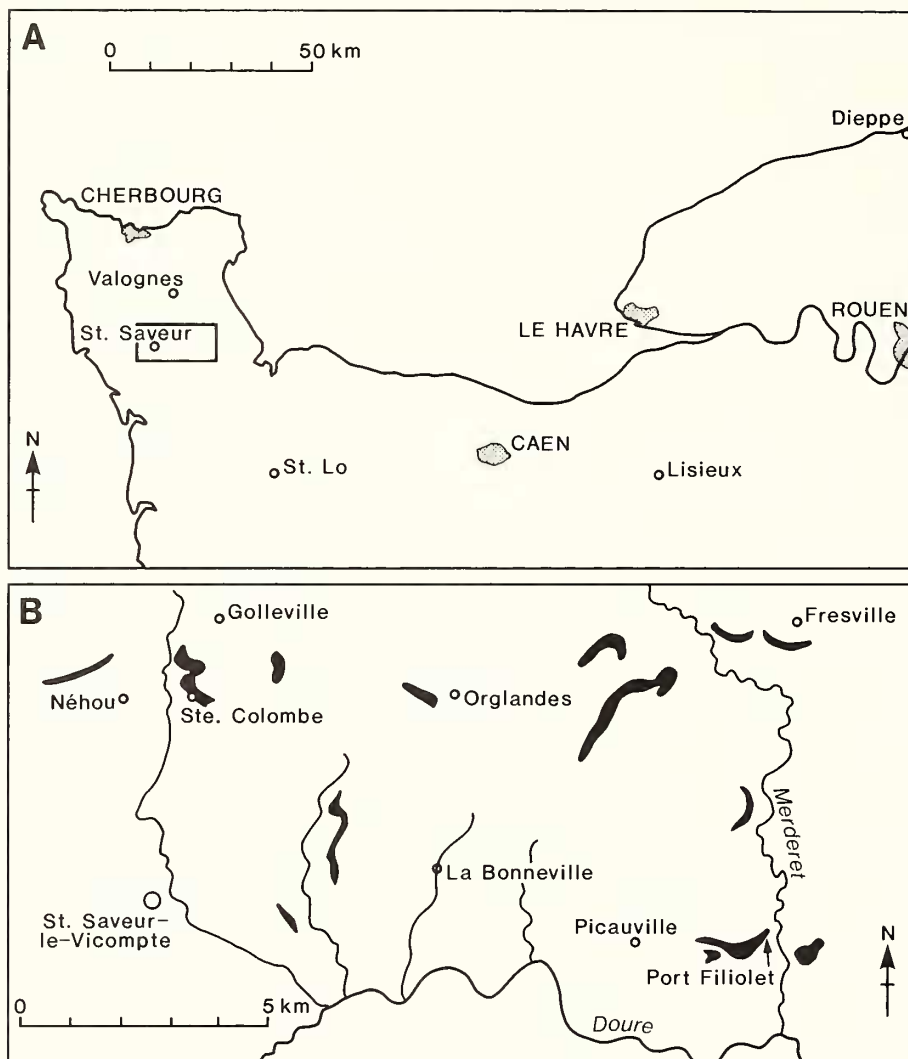
ABSTRACT. The Calcaire à *Baculites* of the Cotentin Peninsula, Manche, France, is a sequence of bioclastic limestones occurring as isolated outliers resting unconformably on rocks of Precambrian to Cenomanian age. Ammonites, chiefly *Baculites*, are locally abundant, and their taxonomy is revised. *B. anceps* Lamarck, 1822 dominates the fauna, with scarce *Hoploscaphites constrictus* (J. Sowerby, 1817) and rare to very rare *Pachydiscus* (*Pachydiscus*) *gollevillensis* (d'Orbigny, 1850), *P. (P.) jacquoti* Seunes, 1890, *P. (P.)* sp., *P. (Neodesmoceras)* *mokotibense* Collignon, 1952, *Anapachydiscus fresvillensis* (Seunes, 1890), *Hoplitoplacenticerus lasfresnayanus* (d'Orbigny, 1841), *Glyptoxoceras* sp., *Diplomoceras cylindraceum* (Defrance, 1816), *B. vertebralis* Lamarck 1801, *Fresvillia constricta* gen. et sp. nov., *Hoploscaphites* sp., and *Acanthoscaphites verneuillanus* (d'Orbigny, 1841).

Limited belemnite and echinoid data, published observations on bryozoans and forams, and the known ranges of some of the key ammonites in the type area of the Maastrichtian and environs and in the White Chalk facies of northern Europe all place the unit in the Upper Maastrichtian; the balance of evidence suggests it is equivalent to the upper *Belemnitella junior* Zone and part of the *Belemnella casimirovensis* Zone. Some localities extend very high in the *casimirovensis* Zone on the basis of the occurrence of late forms of *H. constrictus* ('variety' *crassus* of authors); there is no positive evidence for the Lower Maastrichtian from the ammonite fauna.

THE stratigraphy and divisions of the Maastrichtian stage are in a state of flux, as the proceedings of the recent colloquium on Cretaceous stage boundaries revealed (Birkelund and Surlyk (eds.) 1984: see especially contributions by Kennedy; Schulz, Ernst, Ernst and Schmid; and Surlyk). The type section at Maastricht in Holland is incomplete, with discontinuities separating Maastrichtian chalks from the Campanian chalks below and Maastrichtian limestones from the Danian above. Even where there are expanded successions with relatively diverse ammonite assemblages (in Denmark: Birkelund 1979; Poland: Blaszkiewicz 1980; USSR: Atabekian 1979; Spain: Ward and Wiedmann 1983) there is little agreement on the range of many classic species or on the zonation of the stage.

The reasons for this are several. There is a dearth of Lower Maastrichtian ammonite assemblages in Europe, and those that are known (e.g. in Galicia: Favre 1869; Styria: Hauer 1847, 1858) are not in sequence; ammonites are rare in the widespread White Chalk facies that dominates the region; and with the exception of Howarth's (1965) study of *Baculites anceps* Lamarck, 1822, none of the types of key taxa have been adequately revised since their initial description. The classic Lower Maastrichtian fauna from Neuberg (Styria, Austria) first noted by Hauer (1847, 1858) is the subject of a forthcoming paper (Kennedy and Summesberger, in press), while revision of the faunas of the Maastricht area is under way (Kennedy 1984a and in prep.). The present contribution focuses on the third classic area for Maastrichtian ammonites in western Europe: the Cotentin Peninsula in Manche, northern France. The presence in this area of Cretaceous limestones rich in *Baculites* (see text-fig. 1) was first noted by de Caumont (1824). Referred to as the Terrain à *Baculites*, Calcaire à *Baculites*, or Craie de Valognes, the sequence was first correlated with the limestones of Maastricht by Hébert (1853) and a Maastrichtian age is now generally attributed to it, although quite where it lies within this stage has been disputed.

Ammonites from this unit were first described by James Sowerby, who introduced *Scaphites constrictus* in 1817. Additional forms were described by Lamarck (1822), d'Orbigny (1840–1842),



TEXT-FIG. 1. A, general location of the area. B, locality map showing the outcrop of the Calcaire à *Baculites* in the Cotentin Peninsula, Manche, France, and some of the commonly cited localities; note that there are no outcrops at Golleville.

Seunes (1890*a, b*, 1891), de Grossouvre (1894), and Spath (1922*a*), including a series of key Maastrichtian taxa. The most important collections were made by C. B. de Gerville in the first half of the nineteenth century; specimens sent to James Sowerby in London, the Humboldt Museum in Berlin, and the Naturhistorisches Museum in Vienna, as well as those described by d'Orbigny (1840–1842) attest to the richness of his collection (lost in the destruction of Caen in 1944). A search of the major European museums has, however, revealed many hundreds of ammonites, mostly *Baculites*, that form the basis of this revision.

The Calcaire à *Baculites* occurs as a series of outliers resting on rocks of Precambrian to Cenomanian age (text-fig. 1). It was widely worked for building stone in the last century

but few outcrops now remain, and the unit is best examined in the walls and gateposts of the bourgeois mansions of the region. A few metres of yellow-weathering white bioclastic tuffeau are still exposed below Veauville Farm at Fresville, near Valognes, but the inhabitants are unwilling to permit access due to the depredations of collectors. The quarry south-west of Golleville marked on the 1:80000 Saint-Lô sheet no longer shows a section. Temporary exposures appear from time to time, but it is now impossible to determine a detailed succession in the unit.

De Grossouvre (1901, pp. 285, 292) provides the best account of the sequence. He described a basal conglomerate 0.2–0.3 m thick, overlain by bioclastic limestone. At Veauville he noted the following details of a part only of the Calcaire à *Baculites*, which he believed to be 4–5 m in total thickness in the Cotentin Peninsula:

'Au-dessous du terrain Tertiaire, on observe:

Banc dur avec fossiles rare	0.33
Calcaire blanc crayeux, finement sableux, un peu noduleux à la partie supérieure. On y trouve: <i>Belemnites mucronata</i> , <i>Cidaris</i> , sp., <i>Nucleolites minimus</i> , etc.; Brachiopodes nombreux; Rhyconelles, Térébratules, Magas, Thecidées. . . . Les Baculites y sont rares et on y rencontre surtout <i>Scaphites constrictus</i>	0.30
Banc noduleux	0.10
Deux bancs durs compacts avec Baculites rares	0.50
Sable calcaire	0.15
Bancs durs	0.50
Banc grumeleux à <i>Catopygus</i> , <i>Salenia</i>	0.30
Bancs très durs, compacts avec nombreux Baculites	0.80

Fond de la carrière.

En dehors des Baculites très nombreux dans certains bancs, la faune est composée principalement de Lamellibranches; les Gastropodes sont très rares. L'étude des diverses espèces de ces deux classes est encore à faire; malheureusement on ne trouve d'ordinaire que des moules assez mal conservés. Parmi les formes les plus abondantes, je citerai seulement *Trigonia*, *Gervillia*, *Ostrea*.

Sur certains points, les Brachiopodes sont assez communs, ainsi que les Échinides.'

Granidor *et al.* (1967) suggest a total thickness of 15–20 m for the sequence, a much higher figure than that given by de Grossouvre.

SYSTEMATIC PALAEONTOLOGY

Location of specimens. The following abbreviations are used to indicate the location of specimens mentioned in the text: BMNH, British Museum (Natural History), London; EMP, École des Mines Collections, formerly in Paris but now in the Université Claude-Bernard, Lyons; FSL, Faculté de Sciences, Université Claude-Bernard, Lyons; FSM, Faculté des Sciences, Le Mans; FSR, Faculté des Sciences, Rennes; GBA, Geologische Bundesanstalt, Vienna; IRSNB, Institut Royal des Sciences Naturelles, Brussels; MHNG, Muséum d'Histoire Naturelle, Genève; MNHH, Musée du Havre, Le Havre; MNB, Museum für Naturkunde, Berlin; MNHP, Muséum National d'Histoire Naturelle, Paris; NHMW, Naturhistorisches Museum, Vienna; OUM, University Museum, Oxford; SP, Collections of the Sorbonne, now in the Université Pierre et Marie Curie, Paris.

Suture terminology. The system of Wedekind (1916), as reviewed by Kullmann and Wiedmann (1970), is used here. E = external lobe, L = lateral lobe, U = umbilical lobe, I = internal lobe.

Dimensions. All dimensions are given in millimeters; D = diameter, Wb = whorl breadth, Wh = whorl height, and U = umbilicus; c = costal and ic = intercostal. Figures in parentheses refer to dimensions as a percentage of diameter. The term *rib index* as applied to heteromorphs is the number of ribs in a distance equal to the whorl height at the mid point of the interval counted.

Synonymies. Only citations which include illustrations of material or important systematic, stratigraphic, or geographic information are included.

Order AMMONOIDEA Zittel, 1884

Suborder AMMONITINA Hyatt, 1889

Superfamily DESMOCERATAE Zittel, 1895

Family PACHYDISCIDA Spath, 1922a

[*nom. transl.* Spath, 1923, p. 39, for Pachydiscinae Spath, 1922a, p. 132]

Genus PACHYDISCUS Zittel, 1884

Type species. *Ammonites neubergicus* Hauer, 1858, p. 12, pl. 2, figs. 1–4, by the subsequent designation of de Grossouvre (1894, p. 177).

Discussion. Kennedy and Summesberger (in press) have reviewed the type species and the genus. Two subgenera are recognized: *P. (Pachydiscus)* with persistent ornament, and *P. (Neodesmoceras)* Matsumoto, 1947, which is virtually smooth through most of its ontogeny. Both occur in the Calcaire à *Baculites*; *Neodesmoceras* was previously known only from the Maastrichtian of the Indo-Pacific region (Madagascar, Japan, Alaska, and California).

Subgenus PACHYDISCUS Zittel, 1884

[= *Parapachydiscus* Hyatt, 1900, p. 570; *Joaquinites* Anderson, 1958, p. 218]

Pachydiscus (Pachydiscus) gollevillensis (d'Orbigny, 1850)

Plates 1–3; Plate 4, figs. 4–6; Plate 5, figs. 12–14, 20–24; Plate 11, figs. 1–5; text-figs. 2, 3p, r, 4c

- 1841 *Ammonites lewesiensis* Mantell; d'Orbigny, p. 336 (*pars*), pl. 101, figs. 1–3; *non* pl. 102, figs. 1 and 2.
- 1850 *Ammonites gollevillensis* d'Orbigny, p. 212 (*pars*).
- non* 1857 *Ammonites gollevillensis* d'Orbigny; Sharpe, p. 48, pl. 17, fig. 2 (= *Pachydiscus sharpei* Spath).
- 1861 *Ammonites exilis* Binkhorst, p. 31, pl. 6, fig. 4.
- 1891 *Pachydiscus gollevillensis* d'Orbigny, sp.; Seunes, p. 10, pl. 14 (5), figs. 1–3.
- 1894 *Pachydiscus gollevillensis* d'Orbigny, sp.; de Grossouvre, p. 214, pl. 29, fig. 4; pl. 31, fig. 9.
- non* 1897b *Pachydiscus gollevillensis* Orb.; Kossmat, p. 82, pl. 6, fig. 1 (= *Pachydiscus compressus* Spath).
- non* 1898 *Pachydiscus gollevillensis* Orb.; Kossmat, p. 97 (162), pl. 15 (21), fig. 1 (= *Pachydiscus compressus* Spath).
- 1907 *Pachydiscus gollevillensis* d'Orb. sp.; Wisniowski, p. 196.
- 1908 *Pachydiscus gollevillensis* (d'Orbigny); de Grossouvre, p. 32, pl. 9, figs. 1 and 2.
- non* 1909 *Pachydiscus* sp. ind. ex aff. *gollevillensis* (d'Orbigny); Kilian and Reboul, p. 43, pl. 19, fig. 3; pl. 20, fig. 1.
- 1913 *Pachydiscus egertoni* Forbes sp.; Nowak, p. 354, pl. 41, fig. 13; pl. 43, fig. 28; pl. 44, fig. 38.
- 1922 *Pachydiscus (Parapachydiscus) gollevillensis* (d'Orbigny); Cottreau, p. 181 (73), pl. 17 (9), fig. 1.
- 1922a *Parapachydiscus valognensis* Spath, p. 122.
- 1927 *Pachydiscus Egertoni* Forbes sp. var. *gollevillensis* d'Orb. sp.; Böhm, p. 217 (*pars*); *non* pl. 13, fig. 2.
- 1929 *Pachydiscus* cf. *gollevillensis* d'Orbigny; Barrabé, p. 181, pl. 22 (8), fig. 14.
- 1930 *Pachydiscus gollevillensis* d'Orbigny; Besairie, p. 566, pl. 26, fig. 4.
- 1931 *Pachydiscus gollevillensis* d'Orbigny; Basse, p. 31, pl. 4, fig. 1; pl. 11, fig. 4.
- ?1938 *Parapachydiscus* nov. sp. aff. *chrishna* Forbes-*gollevillensis* d'Orbigny; Collignon, p. 68 (18), pl. 1, fig. 6.
- non* 1940 *Pachydiscus* aff. *gollevillensis* (d'Orbigny); Spath, p. 45, pl. 2, fig. 1.
- 1951 *Pachydiscus neubergicus* Hauer var. *nowaki* Mikhailov, var. nov., p. 65.
- non* 1951 *Pachydiscus gollevillensis* d'Orbigny; Mikhailov, p. 66, pl. 8, fig. 39.
- 1959 *Pachydiscus gollevillensis* (d'Orbigny); Naidin and Shimanskij, p. 187, pl. 11, figs. 1–3.
- non* 1963 *Pachydiscus* sp. no. 1 cfr. *P. gollevillensis* (d'Orbigny); Young, p. 56, pl. 8, fig. 5; pl. 17, fig. 5; text-fig. 10c, o.
- non* 1963 *Pachydiscus* sp. no. 2 cfr. *P. gollevillensis* (d'Orbigny); Young, p. 56, pl. 13, figs. 1, 2, 5; pl. 14, fig. 4; pl. 17, figs. 1 and 8; text-fig. 10d, g.
- non* 1963 *Pachydiscus* sp. no. 3 cfr. *P. gollevillensis* (d'Orbigny); Young, p. 57, pl. 14, figs. 2 and 3; text-figs. 7n, 8h.

- 1964 *Pachydiscus gollevillensis* (d'Orbigny); Tsankov, p. 160, pl. 6, fig. 3; pl. 7, fig. 4; pl. 9, fig. 1.
 1969 *Pachydiscus gollevillensis gollevillensis* (d'Orbigny); Atabekian and Akopian, p. 4, pl. 1, fig. 1.
non 1969 *Pachydiscus gollevillensis armenicus* Atabekian and Akopian, p. 8, pl. 1, fig. 2; pl. 3, figs. 1 and 2.
 1971 *Pachydiscus gollevillensis* d'Orb.; Collignon, p. 24, pl. 649, figs. 2402 and 2403; pl. 650, figs. 2404–2406.
 1980 *Pachydiscus gollevillensis nowaki* Michailov, 1951; Blaszkiewicz, p. 45 (*pars*), pl. 35, figs. 2 and 3 only.
 1982 *Pachydiscus* (*Pachydiscus*) *gollevillensis* (d'Orbigny); Martinez, p. 82, pl. 7, fig. 1.
 1982 *Pachydiscus gollevillensis gollevillensis* (d'Orbigny, 1841); Tsankov, p. 36, pl. 15, fig. 2, ? figs. 1 and 3; pl. 16, fig. 2.
non 1982 *Pachydiscus gollevillensis armenicus* Atabekjan and Hacobjan, 1969; Tsankov, p. 37, pl. 16, figs. 3 and 4.

Types. This is a *Prodrome* species, introduced by d'Orbigny in 1850 as *nomen novum* for *Ammonites lewesiensis* d'Orbigny (not Mantell): *17. *Gollevillensis*, d'Orb. 1847. *A. lewesiensis*, d'Orb., 1842. *Paléont. franc., Terr. cret.*, pl. 101 et 102, fig. 1 (*non* Sowerby). France, Golleville, Fresville (Manche)' (d'Orbigny 1850, p. 212). In *Paléontologie Française* d'Orbigny (1841, p. 336, pl. 101; pl. 102, figs. 1 and 2) notes that de Gerville had found the species at Golleville and Fresville.

The de Gerville Collection, formerly at Caen, was destroyed during the Second World War, while there are no specimens from either of the above localities listed in the catalogue of the d'Orbigny Collection under *A. gollevillensis* or *lewesiensis*. De Gerville sent ammonites from the Calcaire à *Baculites* to several of his contemporaries; there are, for instance, specimens labelled in his distinctive style in the Museum für Naturkunde, Berlin, Naturhistorisches Museum, Vienna, and the British Museum (Natural History). In the case of material sent to James Sowerby, one was described as *A. constrictus* in 1817, so dating the transaction some twenty-four years earlier at minimum than publication of *Paléontologie Française* and rendering it unlikely (but not impossible) that the associated *Pachydiscus* in Sowerby's Collection were studied by d'Orbigny and are thus surviving syntypes. Because d'Orbigny's protographs (reproduced here as text-fig. 2) represent at least two species, and because the original of his plate 101 is sufficiently idealized to be interpretable as either *P. gollevillensis* of authors or *P. valognensis* (Spath, 1922) for those who believe these species to be distinct, neotype designation is desirable. BMNH C38179 (Pl. 1, figs. 1–3) is so designated in the interest of nomenclatural stability; the specimen being from Fresville and one of the specimens sent to James Sowerby by de Gerville.

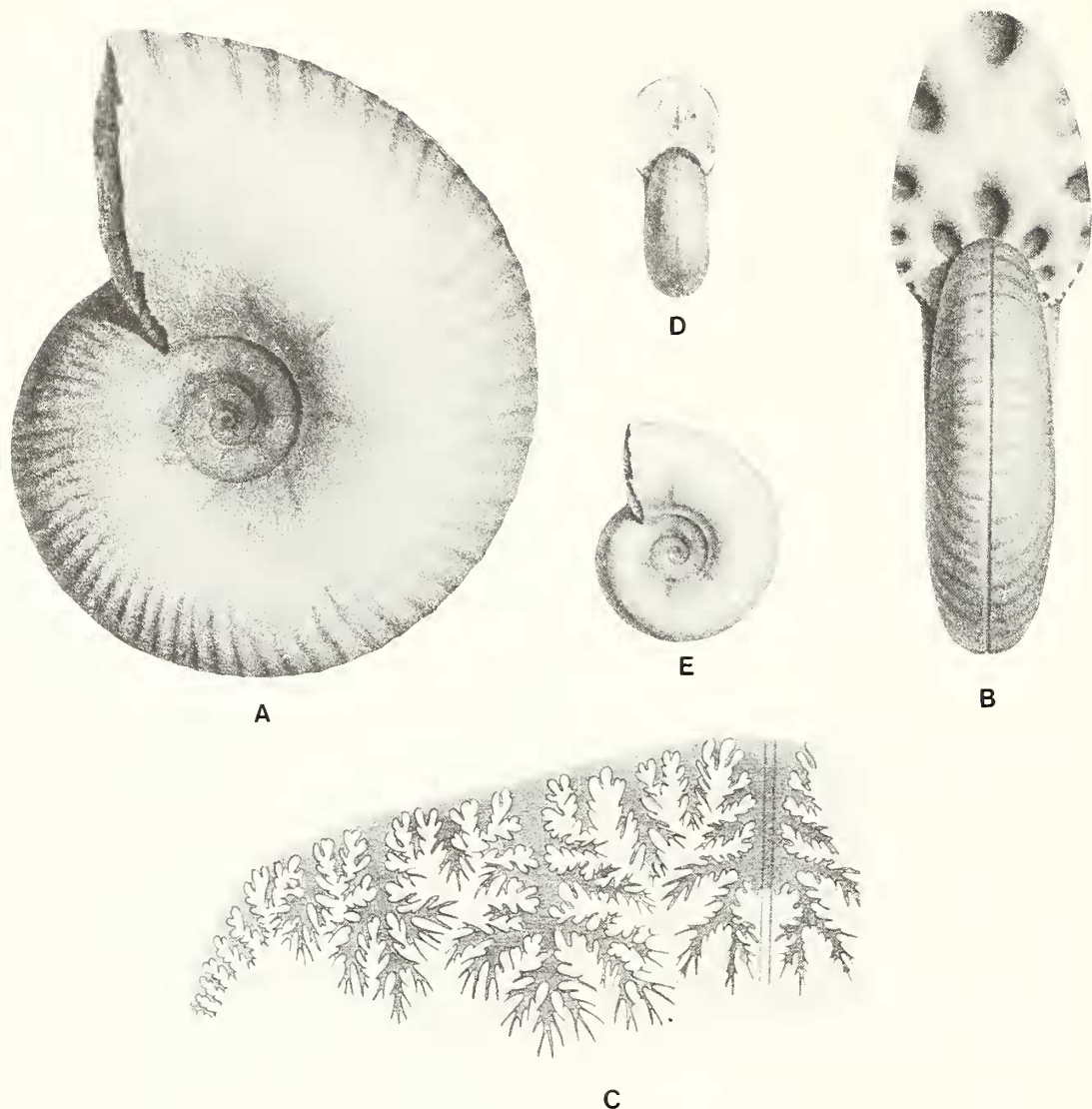
Material. BMNH 50135 from Valognes, the holotype by monotypy of *Parapachydiscus valognensis* Spath, 1922a (Pl. 2, figs. 1–3); BMNH C38178 and C70651 (internal and external moulds) from Fresville (*ex* J. Sowerby, *ex* de Gerville Collection); MNHP unreg. (de Vibraye Collection) from Fresville; SP 19 from Golleville (the original of Seunes 1891, pl. 14 (5), fig. 3; the repository given by Seunes is an error); EMP unreg., two specimens from Fresville or Valognes (the originals of Seunes 1891, pl. 14 (5), figs. 1 and 2; the repository given by Seunes is an error); SP unreg. from Fresville (the original of de Grossouvre 1894, pl. 31, fig. 9); FSR 12, a juvenile from Fresville (Seunes Collection); MNHH 5856, from Port Filiolet, Picauville; MHNG, two unreg. specimens (*ex* Pictet Collection) from Fresville; MNB no. Hi, from Valognes (*ex* de Gerville Collection).

Dimensions

	<i>D</i>	<i>Wb</i>	<i>Wh</i>	<i>Wb: Wh</i>	<i>U</i>
SP19	49.1(100)	14.6(29.7)	20.9(42.6)	0.7	12.6(25.7)
	105.0(100)	31.0(29.5)	42.0(40.0)	0.74	27.5(26.2)
BMNH C38179 (neotype)	112.7(100)	33.6(29.8)	49.5(43.9)	0.68	27.1(24.1)
BMNH 50135 at	101.5(100)	— (—)	43.5(42.9)	—	26.0(25.6)
EMP unreg. (Seunes, pl. 14 (5), fig. 1)	125.0(100)	33.0(26.4)	49.6(39.7)	0.67	30.0(24.0)
EMP unreg. (Seunes, pl. 14 (5), fig. 2)	75.3(100)	— (—)	32.9(43.7)	—	17.9(23.8)
BMNH C38178	51.0(100)	— (—)	23.0(40.3)	—	14.0(24.6)

Description. All specimens are internal moulds of phragmocones. No body-chambers known. Coiling moderately involute, with small, shallow umbilicus comprising around 25% of diameter.

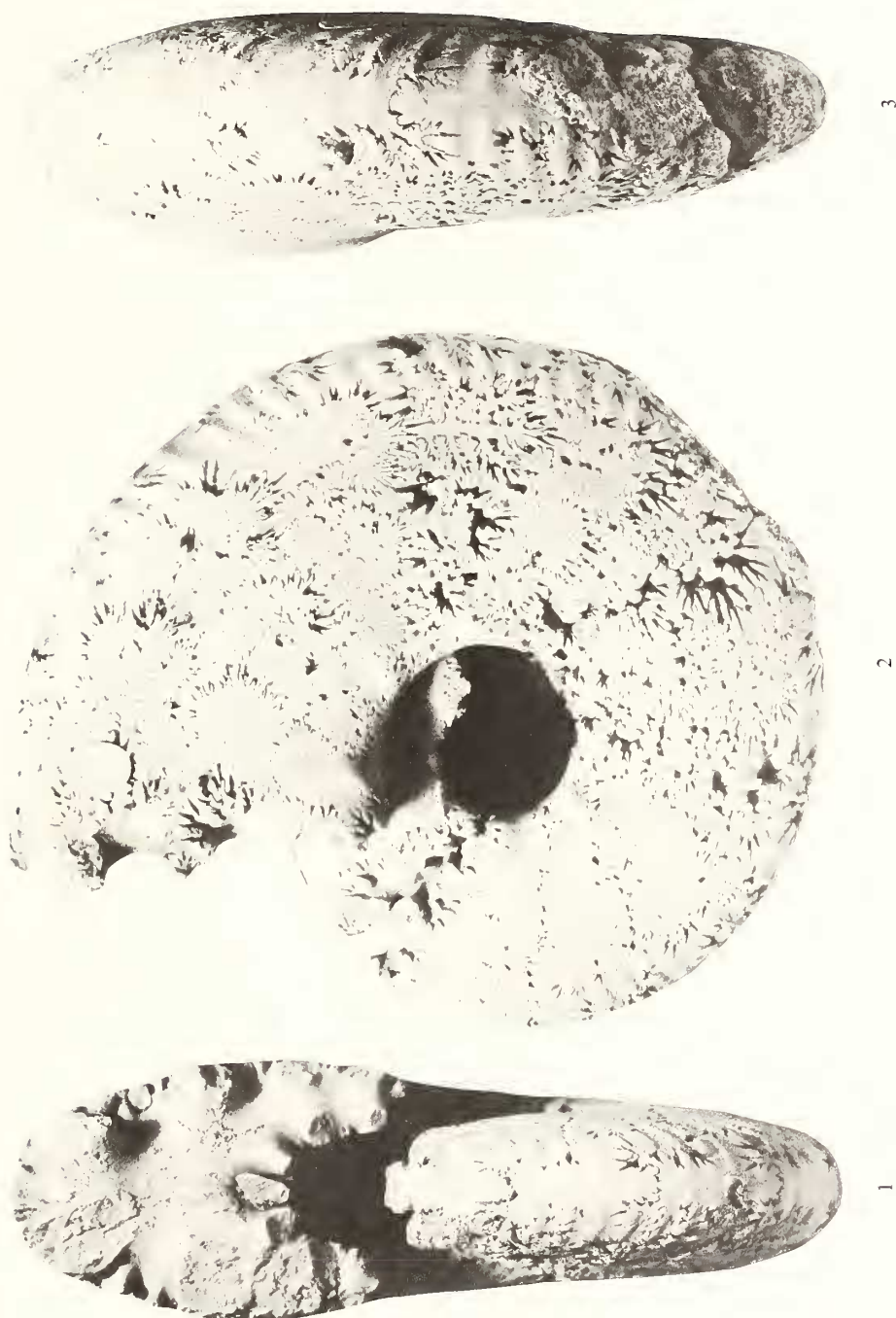
Umbilical wall low and rounded, whorl section compressed (whorl breadth to height ratio ranges from 0.67 to 0.75) with greatest breadth well below mid-flank (text-fig. 3P, R). Inner flanks broadly rounded, outer flanks flattened and convergent, ventrolateral shoulders broadly rounded, venter flattened.

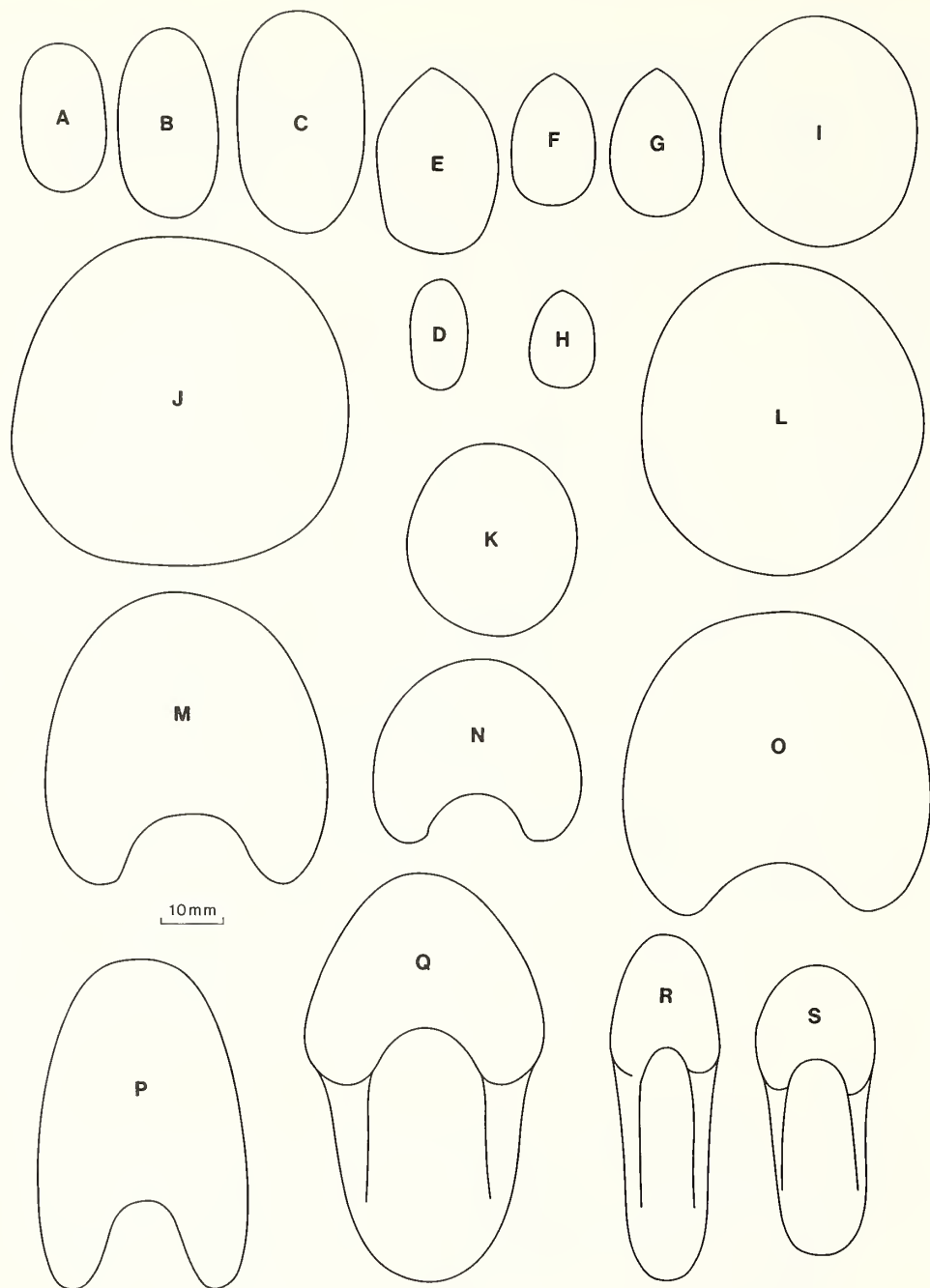


TEXT-FIG. 2. Copies of d'Orbigny's (1842) photographs of *Ammonites lewesiensis*, which he renamed *A. gollevillensis* in 1850. A-C, copies of his plate 101, figs. 1-3 which correspond to the generally accepted view of the species. D, E, copies of his plate 102, figs. 1 and 2, here interpreted as *Pachydiscus* (*Pachydiscus*) *jacquoti* Seunes, 1890a. All figures reproduced at original size.

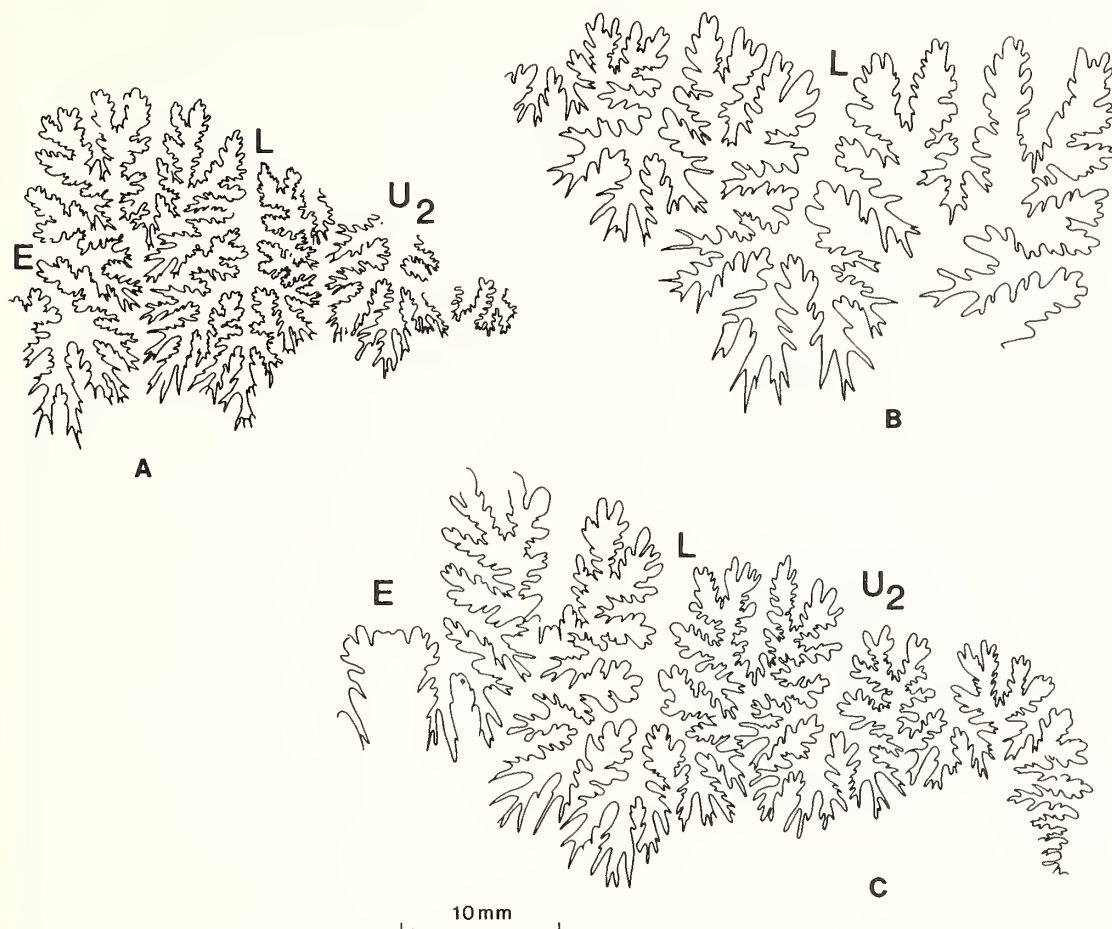
EXPLANATION OF PLATE I

Figs. 1-3. *Pachydiscus* (*Pachydiscus*) *gollevillensis* (d'Orbigny, 1850), BMNH C38179, neotype, from Upper Maastrichtian Calcaire à *Baculites* of Fresville, Manche, France, $\times 1$.





TEXT-FIG. 3. Whorl sections. A-D, *Baculites vertebralis* Lamarck, 1801. A, BMNH C70591; B, NHMW 7460; C, MHNG unreg. (Pictet Collection); D, BMNH C70592. E-H, *B. anceps* Lamarck, 1822. E, NHMW 7482; F-H, MHNG unreg. (Pictet Collection). I-L, *Diplomoceras cylindraceum* (Defrance, 1816). I, BMNH C37027; J, FSR 4; K, MHNG unreg. (Pictet Collection); L, FSR 5. M, N, Q, *Anapachydiscus fresvillensis* (Seunes, 1890a), based on BMNH C524. O, S, *Pachydiscus (Pachydiscus) jacquoti* (Seunes, 1890a). O, BMNH C38175; S, BMNH C38177. P, R, *P. (P.) gollevillensis* (d'Orbigny, 1850). P, BMNH C38179; R, BMNH C38178.



TEXT-FIG. 4. External sutures. A, *Anapachydiscus fresvillensis* (Seunes, 1890a), BMNH C524. B, *Pachydiscus* (*Pachydiscus*) *jacquoti* Seunes, 1890a, BMNH C38175. C, *P. (P.) gollevillensis* (d'Orbigny, 1850), MHNG unreg. (Pictet Collection).

Shell smooth to a diameter of 16 mm (Pl. 5, figs. 20 and 21; Pl. 11, fig. 1); first ornament to appear is small umbilical bullae (Pl. 5, fig. 13; Pl. 11, figs. 2 and 3), which give rise to feeble flexuous prorsiradiate ribs and striae that generally efface on outer flank, although in some specimens there are feeble ribs and depressions on venter (Pl. 11, fig. 2). This stage persists to a diameter of 40 mm (Pl. 5, figs. 13 and 22; Pl. 11, figs. 4 and 5), beyond which strong ventral ribs appear. From this point to maturity (Pls. 1–3; Pl. 4, figs. 4–6) there are nine to eleven umbilical bullae per whorl. These arise as low swellings on umbilical wall, strengthen over the shoulder, and are elongate, crescentic, and of variable strength within (e.g. Pl. 3, fig. 2) and between individuals (compare Pl. 1 and Pl. 3, figs. 1–3). Where strongly developed they extend as ribs across inner flank before declining (Pl. 3, fig. 2); in some cases they appear to subdivide across outer flank (Pl. 3, fig. 4) with secondary ribs intercalated (Pl. 3, figs. 2 and 4). In other specimens (Pl. 1, fig. 2; Pl. 2, fig. 2; Pl. 4, fig. 5) ornament is virtually effaced at mid-flank. In all specimens, ribs strengthen on ventrolateral shoulder, where they are distinctly prorsiradiate, blunt, and rounded, and separated by slightly wider interspaces. All ribs pass straight across venter, and are interrupted by narrow groove marking siphonal line. There are approximately eighty ventral ribs corresponding to the nine to eleven umbilical bullae.

Suture line deeply and intricately subdivided, with symmetrically bifid saddles and markedly retracted umbilical lobe (text-fig. 4c).

Discussion. The neotype is a specimen according well with the figures of Seunes (1891) and de Grossouvre (1894). It is generally comparable with d'Orbigny's pl. 101, which most authors have used as a basis for the species, whereas d'Orbigny's pl. 102, figs. 1 and 2 are obviously a juvenile *Pachydiscus jacquoti* Seunes, 1890a.

P. valognensis (Spath, 1922a), the holotype of which is figured for the first time as Plate 2, is inseparable from *P. gollevillensis*. *P. neubergicus nowaki* Mikhailov, 1951 (p. 65) is based on the original of Nowak (1913, p. 354, pl. 41, fig. 13); it has a somewhat coarser ventral ornament, but I can see no criteria on which to separate it specifically from *P. gollevillensis*. Blaszkiewicz (1980, p. 45, pl. 35, figs. 1–3, 9) differentiates it from *P. gollevillensis sensu stricto* on the basis of the more numerous umbilical bullae, wider umbilicus, and more conspicuously reduced costulation in the central parts of the sides. The original of his pl. 35, figs. 1 and 9 bears little resemblance to the *gollevillensis* group, however. *P. g. armenicus* Atabekian and Akopian, 1969 (p. 8, pl. 1, fig. 2; pl. 3, figs. 1 and 2) from the Maastrichtian of Armenia has many more umbilical bullae (sixteen to twenty) than the present material (nine to eleven) and sixty-two to seventy-three ventral ribs. It seems distinct enough from the material described here.

P. gollevillensis is a close ally and, I believe, a descendant of the older *P. neubergicus* (Hauer, 1858) (p. 12 (*pars*), pl. 2 (3), figs. 1–3 only), the lectotype of which is illustrated in Plate 4, fig. 3. This species has 50% more umbilical bullae than *P. gollevillensis*, primary ribs that extend across the flank and bi- or trifurcate on the ventrolateral shoulder, far fewer ventral ribs, and a wider umbilicus. Evolution thus involved a reduction in the number of umbilical bullae, effacement of lateral ornament, and an increase in number and decrease in strength of ventral ribs. It is thus perfectly possible that *P. g. armenicus* may be an intermediate stage in this sequence which has attained the finer ventral ornament of *gollevillensis* while retaining the style of umbilical ribbing of *neubergicus*.

Occurrence. Calcaire à *Baculites*, Upper Maastrichtian of Fresville, Golleville, 'Valognes' and Port Filiolet, Picauville, Manche, France; Hommes Morts, Lleida, Spain; Poland, north Germany, Austria, Armenian SSR, northern Caucasus, Crimea, Bulgaria, the Bithynian Peninsula, Turkey, and Madagascar.

Pachydiscus (Pachydiscus) jacquoti Seunes, 1890a

Plate 5, figs. 3–11, 15–19; Plate 6; text-figs. 2D, E, 3O, S, 4B.

- 1841 *Ammonites lewesiensis*, Sowerby; d'Orbigny, p. 336 (*pars*), pl. 102, figs. 1 and 2.
- 1850 *Ammonites gollevillensis* d'Orbigny, p. 212 (*pars*).
- 1861 *Ammonites colligatus* Binkhorst, p. 25 (*pars*), pl. 6, fig. 3a–f (?); pl. 7, fig. 2a, b only.
- 1890a *Pachydiscus Jacquoti*, Seunes, 1888; Seunes, p. 5, pl. 3 (2), figs. 1–3.
- 1890b *Pachydiscus Jacquoti*, Seunes; Seunes, p. 237, pl. 9, figs. 1–4.
- 1891 *Pachydiscus Jacquoti*, Seunes; Seunes, p. 9, pl. 12 (3), fig. 4.
- 1894 *Pachydiscus neubergicus*, F. von Hauer, sp. emend., A. de Grossouvre; de Grossouvre, p. 207 (*pars*), pl. 26, fig. 3; pl. 38, fig. 3.
- 1908 *Pachydiscus neubergicus* v. Hauer, sp. emend. de Gross.; de Grossouvre, p. 30, pl. 9, figs. 3 and 4.
- 1938 *Pachydiscus neubergicus* v. Hauer var. *Jacquoti* Seunes; Collignon, p. 48 (98), pl. 11, fig. 1.
- ?1952 *Pachydiscus* cf. *P. jacquoti* Seunes, 1890; Usher, p. 72, pl. 11, figs. 1–3; pl. 31, fig. 1.

EXPLANATION OF PLATE 2

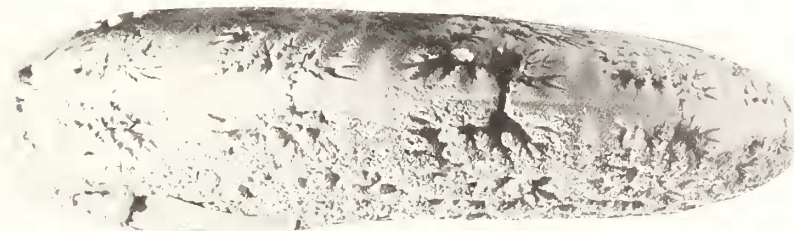
Figs. 1–3. *Pachydiscus (Pachydiscus) gollevillensis* (d'Orbigny, 1850), BMNH 50135, holotype of previously unfigured *Parapachydiscus valognensis* Spath, 1922a, from Upper Maastrichtian Calcaire à *Baculites* of Valognes, Manche, France, $\times 1$.



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- 1969 *Pachydiscus egertoni jacquoti* Seunes; Atabekian and Akopian, p. 9, pl. 1, fig. 3; pl. 2, fig. 2; pl. 4, fig. 1.
 1971 *Pachydiscus jacquoti* Seunes; Collignon, p. 36, pl. 655, figs. 2412 and 2413.

Types. Seunes figured three specimens (1890a, pl. 3 (2), figs. 1–3) and mentioned a series of other specimens from the Pyrénées-Occidentales (now Pyrénées-Atlantiques) (possibly those figured by him in 1890b, pl. 9, figs. 1–4) as well as a specimen from north-west of Alcoy, Alicante, Spain; all are syntypes of the species. I have been unable to trace the original of his pl. 3 (2), fig. 1, which was in the Janet Collection, nor the original of his pl. 3 (2), fig. 2, said to be in the EMP Collections. The original of his fig. 3 survives in the latter collection (unreg.) but is the smallest of the three (Pl. 9, fig. 7) and does not show the characteristic adult features of the species. I hesitate to designate a lectotype in these circumstances. If the original of Seunes (1890a, pl. 3 (2), fig. 1) is located, it should be designated lectotype.

Material. BMNH C38175 from Fresville; BMNH C38177 and C70625, parts of the same specimen but labelled 'Fresville' and 'near Valognes' respectively (all J. Sowerby, *ex de Gerville* Collection); FSR 7 from Fresville (Seunes Collection); FSR 8–10, labelled 'Manche'. The original of Seunes (1891, pl. 12 (3), fig. 4), originally in the de Lapparent Collection (formerly in the Institute Catholique, Paris), has not been traced.

Dimensions

		<i>D</i>	<i>Wb</i>	<i>Wh</i>	<i>Wb:Wh</i>	<i>U</i>
BMNH C38175	ic	122.0(100)	45.2(37.1)	49.9(40.9)	0.91	39.2(32.1)
at diameter	c	94.0(100)	36.6(38.9)	38.0(40.4)	0.96	29.9(31.8)
BMNH C38177	c	49.0(100)	19.0(38.7)	18.3(37.8)	1.02	16.0(32.7)
at diameter	ic	32.6(100)	13.7(42.0)	12.0(36.8)	1.14	10.0(30.7)
FSR 7	c	30.4(100)	12.9(42.4)	12.0(39.4)	1.08	9.8(32.2)

Description. All specimens are internal moulds of juvenile phragmocones; no adult body-chambers are known from the Cotentin. Coiling moderately evolute ($U = 30.7\text{--}32.7\%$), whorls expanding slowly. Umbilicus shallow, with rounded, outwards-inclined wall. Umbilical shoulder broadly rounded, inner flanks broadly rounded, outer flanks flattened and convergent, venter broadly rounded. Whorl section slightly depressed intercostally up to a diameter of 70 mm, thereafter slightly compressed. Greatest breadth at umbilical bullae at all diameters.

Shell initially smooth (Pl. 5, figs. 15 and 19). Weak umbilical bullae, four per half whorl, first appear at a diameter of 12 mm, and are only ornament up to diameter of 35–45 mm (Pl. 5, figs. 9–11; Pl. 9, fig. 7) where they number up to eight per whorl. Ornament thereafter (Seunes 1890a, pl. 2 (3), fig. 2; de Grossouvre 1894, pl. 26, fig. 3) shows bullae elongating into pairs of narrow and distant prorsiradiate ribs; shorter intercalated ribs also appear. Overall rib density increases, with thirteen or fourteen bullae at a diameter of 70 mm (Pl. 6, fig. 2) and twice this number of ribs at ventrolateral shoulder. Ribs weaken over venter, interrupted by a narrow groove over siphonal line.

Secondary ribs decline beyond 90 mm, and in largest specimen seen (Pl. 6) there are fifteen umbilical bullae at 122 mm diameter which become progressively wider spaced over last half whorl, where they give rise to single ribs that decline on flank and virtually disappear over venter. Secondary ribs weaken and eventually disappear by same diameter. What I take to be the adult body-chamber (Seunes 1890b, pl. 9, fig. 4) has distant primary ribs only.

Suture (text-fig. 4b) is intricately subdivided, with large external lobe, deep E, large asymmetrically bifid E/L, deeply incised bifid L and U2, and smaller asymmetrically bifid L/U2.

Discussion. De Grossouvre (1894, p. 207) erred in uniting this species with *P. neubergicus* Hauer, 1858 (Pl. 4, fig. 3), which has a compressed oval whorl section when juvenile. Although also ornamented by umbilical bullae which give rise to primary ribs only, these are coarser, blunter, and more numerous. In middle growth, as represented by the lectotype (Hauer 1858, p. 12 (*pars*), pl. 2, figs. 1–3 only) (see Pl. 4, fig. 3), Hauer's species is more involute, with more numerous primary ribs and bullae and many

EXPLANATION OF PLATE 3

Figs. 1–4. *Pachydiscus* (*Pachydiscus*) *gollevillensis* (d'Orbigny, 1850), from Upper Maastrichtian Calcaire à *Baculites* of either Fresville or Valognes, Manche, France. 1–3, EMP unreg., heavily restored in plaster; original of Seunes (1891, pl. 14 (5), fig. 1). 4, EMP unreg.; original of Seunes (1891, pl. 14 (5), fig. 2). All $\times 1$.



KENNEDY, *Pachydiscus* (*Pachydiscus*)

short secondaries and intercalatories on ventrolateral shoulders and venter. At maturity, topotypes of *P. uebergicus* lose all but umbilical bullae and primary ribs that efface on the outer flank. *P. jacquoti* is much more evolute and coarser ribbed than *P. gollevillensis*, and lacks the fine, dense, ventral ribbing of that species. It should be noted that d'Orbigny's smaller figured specimen (1841, pl. 102, figs. 1 and 2) is a juvenile *jacquoti*.

Perhaps the closest ally of *P. jacquoti* is *P. egertoni* (Forbes, 1846a) (p. 108, pl. 9, fig. 1), of which *P. gauesia* (Forbes, 1846a) (p. 103, pl. 7, fig. 8) is a synonym. The type material is from the Maastrichtian Valudayur Beds of Pondicherry, southern India, and the specimen figured by Forbes (BMNH C51038) is here designated lectotype. The species differs from *P. jacquoti* (which Atabekian and Akopian 1969 regarded as no more than subspecifically distinct) in having weaker ornament (effaced on the venter), a smaller umbilicus, higher compressed whorls with strongly convergent flanks, and a narrow arched venter with ornament declining from a much smaller diameter. Kossmat's specimen (1898, p. 94 (159), pl. 15 (21), fig. 4a-c) may be a *jacquoti*, however.

P. j. australis Henderson and McNamara, 1985 (p. 76, pl. 8, figs. 1, 2, 7-10; text-figs. 12a, 13b, 14, 15a) is a coarser ribbed form that retains its secondary ribs to a large diameter (see also Wetzel 1930, p. 85, pl. 13, fig. 2).

Occurrence. Calcaire à *Baculites*, Upper Maastrichtian, of Fresville, Manche, France; Upper Maastrichtian Marnes de Nay of Gan-Rebaneq, Pyrénées-Atlantiques, France; Upper Maastrichtian of Kunraed, Holland; Maastrichtian of Armenia, Madagascar, perhaps British Columbia, and southern India.

Pachydiscus (*Pachydiscus*) sp.

Plate 5, figs. 1 and 2

1890a *Pachydiscus colligatus*, Binkhorst sp.; Seunes, p. 6, pl. 3 (2), fig. 4.

Material. The original of Seunes (1890a, pl. 3 (2), fig. 4), from Fresville; EMP unregistered.

Discussion. This slowly expanding juvenile *P. (Pachydiscus)* with depressed whorl section and numerous low, narrow, alternately long and short ribs differs from all other specimens from the Calcaire à *Baculites*. Seunes referred it to *Annuonites colligatus* without hesitation, comparing it to Binkhorst's (1861) pls. 7 and 8a; Binkhorst's figures show several species of pachydiscid, and the present specimen is certainly not conspecific with those mentioned by Seunes. It is left in open nomenclature at this time.

Occurrence. As under *Material*.

Subgenus NEODESMOCERAS Matsumoto, 1947 (republished in English, 1951)

[= *Neodesmoceras* Matsumoto, 1938, p. 193, *nom. nud.*]

Type species. *P. (Neodesmoceras) japonicus* Matsumoto, 1947, p. 39, by original designation.

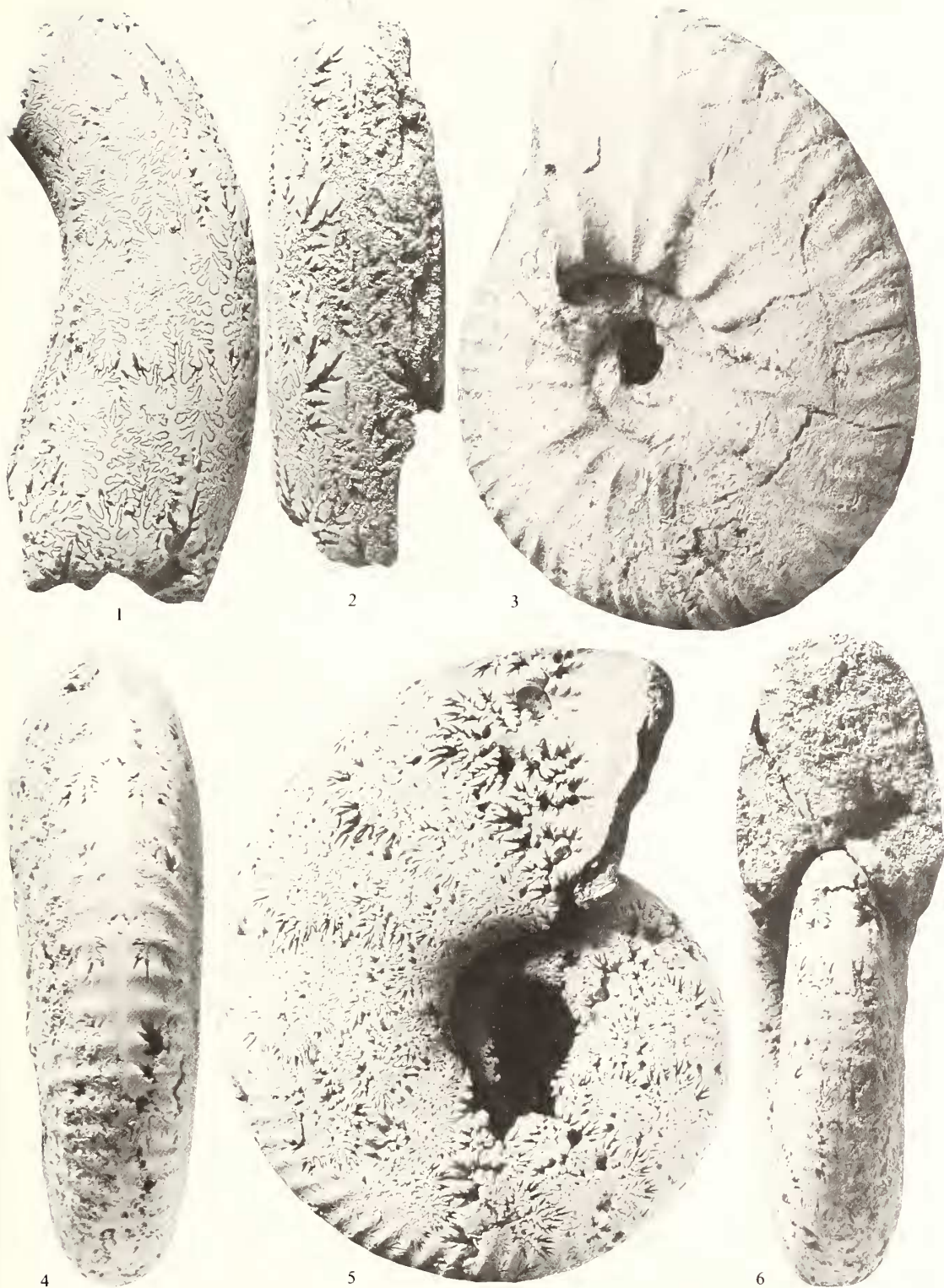
EXPLANATION OF PLATE 4

Figs. 1 and 2. *Diplomoceras cylindraceum* (Defrance, 1816), BMNH C70644 (ex J. Sowerby, ex de Gerville Collection), from near Valognes.

Fig. 3. *Pachydiscus (Pachydiscus) uebergicus* (Hauer, 1858), GBA 1858.01.6, lectotype, from Maastrichtian of Neuberg, Styria, Austria; original of Hauer (1858, pl. 2, figs. 1-3).

Figs. 4-6. *P. (P.) gollevillensis* (d'Orbigny, 1850), EMP unreg., from Fresville; original of de Grossouvre (1894, pl. 31, fig. 9).

All except fig. 3 from Upper Maastrichtian Calcaire à *Baculites* of Cotentin Peninsula, Manche, France. All $\times 1$.



KENNEDY, *Diplomoceras*, *Pachydiscus* (*Pachydiscus*)

Pachydiscus (Neodesmoceras) mokotibense Collignon, 1952

Text-fig. 5

1952 *Neodesmoceras mokotibense* Collignon, p. 81, pl. 28, fig. 2.1955 *Neodesmoceras mokotibense* Collignon; Collignon, p. 75, pl. 27, fig. 2.1971 *Neodesmoceras mokotibense* Collignon; Collignon, p. 32, pl. 653, fig. 2410.

Type. Holotype by original designation is the original of Collignon (1952, pl. 28, fig. 2; 1955, pl. 27, fig. 2), from the Maastrichtian of Mokotibe, Madagascar. There are also four paratypes, all in the EMP Collections.

Material. SP unreg., from the Fosse de la Bonneville.

Description. The specimen is a wholly septate internal mould some 140 mm in diameter. Coiling involute, umbilicus comprising approximately 20% of diameter. Whorl section as broad as high. Inner flanks broadly rounded, outer flanks flattened, convergent, ventrolateral shoulder and venter broadly rounded. There are traces of narrow, distant ribs on outer flank and venter at smallest diameter visible, thereafter lost.

Suture line intricately subdivided.

Discussion. *Neodesmoceras* covers a range of *Pachydiscus* in which ornament is lost at an early stage, leaving the shell almost smooth. The present specimen is the first European representative of the subgenus, previously known only from the Indo-Pacific region (Madagascar, Zululand, Japan, Alaska, California). Its nearly equidimensional whorl section easily distinguishes it from *P. (N.) japonicus*, *P. (N.) obsoletiformis* Jones, 1963 (p. 40, pl. 26, figs. 1, 4–8; pls. 27 and 28; text-figs. 20 and 22A), *P. (N.) gracilis* Matsumoto, 1979 (p. 60, pl. 10, figs. 1–3; pl. 11, fig. 1; pl. 12, fig. 2; text-fig. 6), and *P. (N.) catarinae* (Anderson and Hanna, 1935) (p. 19, pl. 11, fig. 1; pl. 2, fig. 1; pl. 3, figs. 1–3). Its overall proportions correspond to those of *P. (N.) mokotibense* Collignon, 1952 (p. 81, pl. 28, fig. 2; republished by Collignon 1955, p. 75, pl. 27, fig. 2; see also Collignon 1971, p. 32, pl. 653, fig. 2410), while comparison with the types (EMP unreg.) and Zululand specimens referred to the species (BMNH C90180–90189) confirms this view. In particular the African material shows periodic distant ventral ribs during early growth, as is seen in the present specimen at the smallest diameter visible.

Occurrence. Upper Maastrichtian, Calcaire à *Baculites* of the Fosse de Bonneville, Manche, France. Maastrichtian of Madagascar and Zululand.

Genus ANAPACHYDISCUS Yabe and Shimizu, 1926

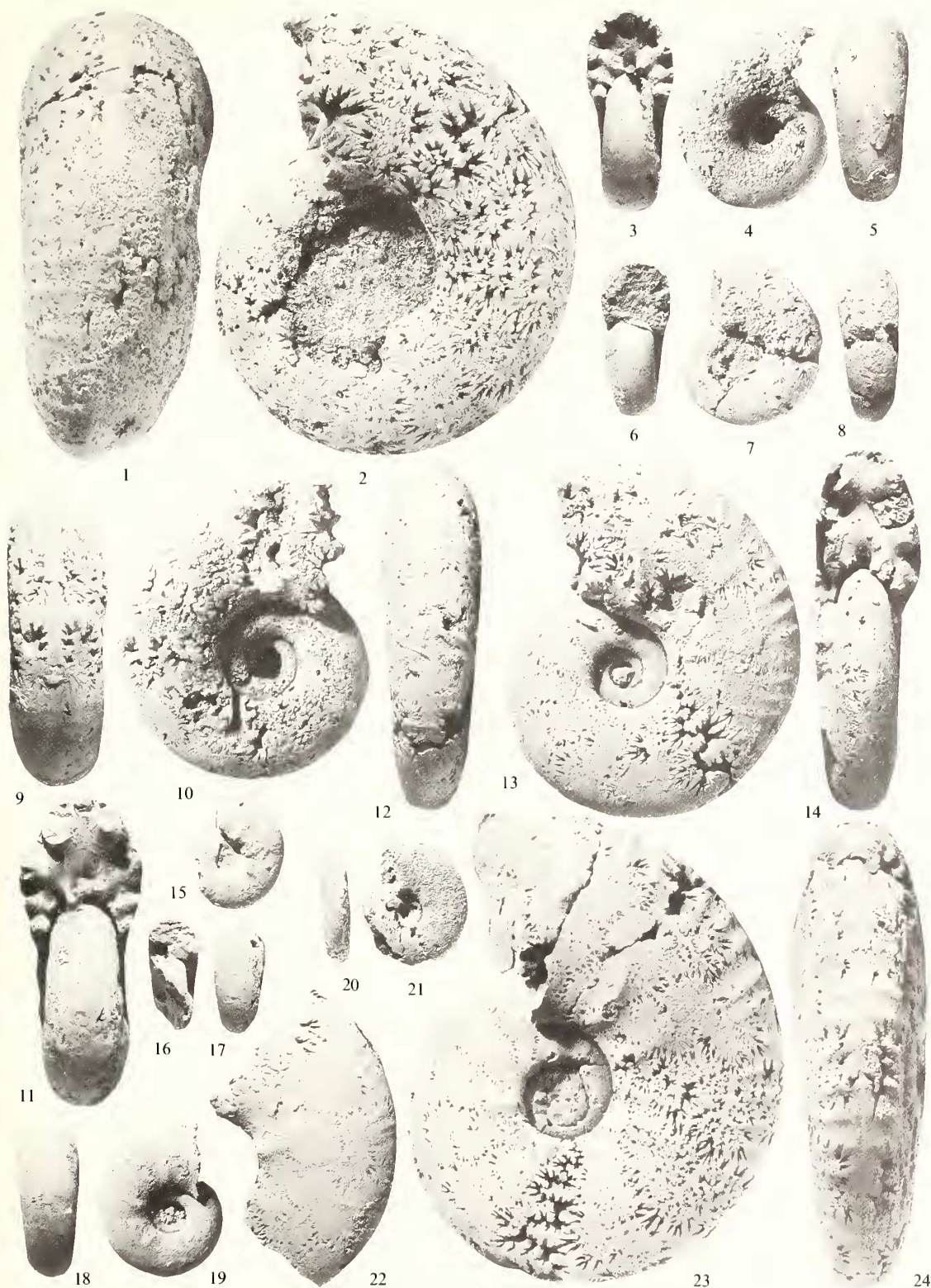
[= *Neopachydiscus* Yabe and Shimizu, 1926, p. 187]

Type species. *Parapachydiscus fascicostatus* Yabe, 1921, p. 57 (5), pl. 8 (1), fig. 5; pl. 9 (2), figs. 2–5, by original designation.

EXPLANATION OF PLATE 5

- Figs. 1 and 2. *Pachydiscus (Pachydiscus)* sp., EMP unreg.; original of Seunes (1890a, pl. 3 (2), fig. 4).
 Figs. 3–11, 15–19. *P. (P.) jacquoti* Seunes, 1890a. 3–5, 9–11, BMNH C38177 (ex J. Sowerby, ex de Gerville Collection). 6–8, FSR8 (ex Seunes Collection). 15–17, FSR9 (ex Seunes Collection). 18 and 19, FSR7 (ex Seunes Collection).
 Figs. 12–14, 20–24. *P. (P.) gollevillensis* (d'Orbigny, 1850). 12–14, BMNH C38178 (ex J. Sowerby, ex de Gerville Collection). 20 and 21, MNH 5856. 22, BMNH C38179 (ex J. Sowerby, ex de Gerville Collection), part of inner whorl of neotype (see also Pl. 1); 23 and 24, EMP unreg.; original of Seunes (1891, pl. 14 (5), fig. 2).

All from Upper Maastrichtian Calcaire à *Baculites* of Fresville, Manche, France, except figs. 20 and 21 which are from Port Filiolet, Picauville, Manche, France. All $\times 1$.



KENNEDY, *Pachydiscus* (*Pachydiscus*)

Anapachydiscus fresvillensis (Seunes, 1890a)

Plates 7 and 8; Plate 9, figs. 1-3; text-figs. 3M, N, Q, 4A

1861 *Animonites colligatus* Binkhorst, p. 25 (*pars*), pl. 6, fig. 3a-f(?); pl. 7, fig. 2c; pl. 8, figs. 1 and 2.1890a *Pachydiscus fresvillensis* Seunes, p. 3, pl. 2 (1), fig. 1.1890b *Pachydiscus fresvillensis* Seunes; Seunes, p. 236, pl. 7, fig. 1; pl. 8, figs. 1-3.

TEXT-FIG. 5. *Pachydiscus* (*Neodesmoceras*) *mokotibense* Collignon, 1952, SP unreg., from Upper Maastrichtian Calcaire à *Baculites* of the Fosse de la Bonneville, Manche, France, $\times 1$.

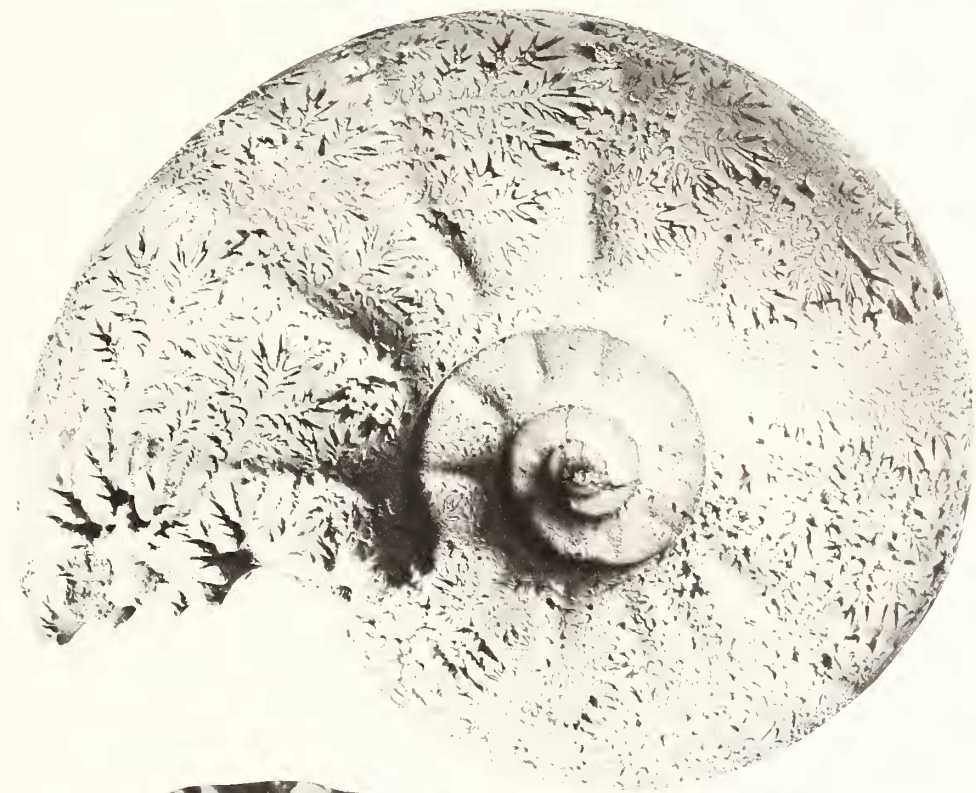
EXPLANATION OF PLATE 6

Figs. 1-3. *Pachydiscus* (*Pachydiscus*) *jacquoti* (Seunes, 1890a), BMNH C38175 (*ex* J. Sowerby, *ex* de Gerville Collection), from Upper Maastrichtian Calcaire à *Baculites* of Fresville, Manche, France, $\times 1$.

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KENNEDY, *Pachydiscus* (*Pachydiscus*)

- ?1890b *Pachydiscus auritocostatus* Schlüter, sp.; Seunes, p. 239, pl. 8, fig. 4 (*non* Schlüter).
 non 1891 *Pachydiscus fresvillensis* Seunes; Seunes, p. 14, pl. 12 (3), fig. 1.
 1894 *Pachydiscus colligatus* von Binkhorst, sp. emend. A. de Grossouvre; de Grossouvre, p. 202 (*pars*), pl. 24, figs. 1 and 3 only (*non* pl. 33, fig. 1).
 1895 *Pachydiscus Quiriquinae* Phillipi; Steinmann, p. 74, pl. 6, fig. 3; text-fig. 5.
 1895 *Pachydiscus Fresvillensis* Seunes; Steinmann, p. 77.
 1906 *Pachydiscus suprenus* Pethö, p. 88, pl. 5, fig. 1.
 1908 *Pachydiscus colligatus*, Binkhorst van den Binkhorst sp. emend. de Gross; de Grossouvre, p. 28 (*pars*), pl. 4, figs. 1–3; pl. 5, fig. 1; pl. 6, fig. 1.
 ?1930 *Pachydiscus sumneri* Maury, p. 155, pl. 13, figs. 1 and 2.
 ?1930 *Parapachydiscus poseidon* Maury, p. 155, pl. 15.
 ?1930 *Canadoceras riogramense* Maury, p. 169, pl. 21, fig. 2.
 1930 *Parapachydiscus* sp. indet. Wetzel, p. 86, pl. 14, fig. 1.
 1938 *Parapachydiscus fresvillensis* Seunes; Collignon, p. 101 (51), pl. 7, figs. 4 and 5; text-figs. O and P.
 ?1952 *Pachydiscus* sp. aff. *colligatus* van Binkhorst; Collignon, p. 79, pl. 26, fig. 2.
 ?1955 *Pachydiscus* sp. aff. *colligatus* van Binkhorst; Collignon, p. 74, pl. 26, fig. 2.
 1969 *Pachydiscus colligatus fresvillensis* Seunes; Atabekian and Akopian, p. 13, pl. 6, fig. 1.
 1971 *Pachydiscus fresvillensis* Seunes; Collignon, p. 30, pl. 652, fig. 2408.
 1985 *Pachydiscus* (*Pachydiscus*) *fresvillensis* Seunes, 1890; Henderson and McNamara, p. 78, pl. 8, figs. 3–6; pl. 9, figs. 1 and 2; text-figs. 12b, 13a, 15b.

Type. Lectotype, here designated, EMP A1186, the original of Seunes (1890a, p. 3, pl. 2 (1), fig. 1), from Fresville.

Material. BMNH C524 (referred to by Spath 1921, p. 265) and C70653, from near Valognes.

Dimensions

		<i>D</i>	<i>Wb</i>	<i>Wh</i>	<i>Wb:Wh</i>	<i>U</i>
EMP A1186 (lectotype)		148.0(100)	72.0(48.6)	77.0(52.0)	0.94	31.0(21.1)
BMNH C524	ic	123.0(100)	— (—)	59.0(48.0)	—	25.6(20.8)
at diameter	ic	106.0(100)	50.0(47.2)	49.5(46.7)	1.01	21.0(19.8)
at diameter	c	67.8(100)	36.3(53.5)	32.3(47.6)	1.12	15.2(22.4)

Description. All specimens studied are internal moulds of macroconch phragmocones, 67–148 mm in diameter. Coiling involute, umbilicus comprising 19.8–22.4% of diameter with 60% of previous whorl covered. Whorl section depressed, reniform in juvenile (breadth to height ratio up to 1.12) with greatest breadth at umbilical shoulder, umbilical wall rounded and undercut, inner flank rounded, outer converging to broadly rounded venter. Whorl breadth to height ratio decreases through ontogeny and section is slightly compressed from 120–130 mm diameter. Up to 60–65 mm (Pl. 9, figs. 1–3), ten or eleven low, broad ribs arise at umbilical seam and develop into prominent umbilical bullae. These give rise to paired (rarely three) ribs, while occasional non-tuberculate ribs arise at shoulder and shorter intercalatories arise on inner flank to give a total of thirty-one or thirty-two ribs per whorl. These are narrow and prorsiradiate on inner flank at smallest diameter visible, curve forwards over ventrolateral shoulder and cross venter in broad convexity, attenuating and effacing over mid-venter. As size increases (Pl. 8) ribs strengthen and are strongest over venter by a diameter of 50 mm. Bullae decline beyond 60–65 mm and migrate out to inner flank position (Pl. 8, fig. 2), giving rise to pairs of ribs with, in addition, both long and short intercalatories that strengthen markedly over venter; there are forty ribs at 115 mm. Umbilical bullae decline beyond 120 mm and ribs progressively efface on inner and middle flank so that, by largest diameter seen in the present material (the lectotype; Pl. 7), ornament is confined to coarse, broadly convex, rounded ribs, forty per whorl, on ventrolateral shoulders and venter only, with smooth flanks on mould at least.

The suture (text-fig. 4A) is finely subdivided.

Discussion. Massive whorls, depressed and with strong umbilical bullae giving rise to groups of ribs, plus the effacement of ornament on all but the ventrolateral shoulders and venter in middle growth

EXPLANATION OF PLATE 7

Figs. 1 and 2. *Anapachydiscus fresvillensis* (Seunes, 1890a), EMP unreg., holotype, from Upper Maastrichtian Calcaire à *Baculites* of Fresville, Manche, France; original of Seunes (1890a, pl. 2 (1), fig. 1), $\times 1$.



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KENNEDY, *Anapachydiscus*

readily distinguish macroconch *A. fresvillensis* from the other pachydiscids present in the Calcaire à *Baculites*. Most workers refer the species to *Pachydiscus*, but the massive, involute whorls and the presence of umbilical spines and tubercles giving rise to paired ribs suggest it is better placed in *Anapachydiscus*. Of the European species, the present form has generally been confused with *P. colligatus* (Binkhorst, 1861). This species is discussed at length elsewhere in my revision of the ammonites of the type Maastrichtian (in prep.). Suffice it to say that the proposed lectotype (the original of Binkhorst 1861, pl. 8, which is also the holotype by monotypy of *P. vandenbroeckii* de Grossouvre, 1894, p. 207) is a much less massive shell, more evolute, and slower expanding; moreover, on moulds, the primary ribs extend to the umbilical shoulder and the secondaries extend well down the flank at a diameter where they have disappeared in *P. (P.) fresvillensis*, while the ventral ribbing is much more subdued in middle growth. The smallest topotype of *P. (P.) colligatus* seen is over 200 mm in diameter, so that comparison of the early stages is difficult. The reader is referred to the revision of the Maastricht fauna noted above for additional discussion. *P. quiriquinae* Steinmann, 1895 (p. 74, pl. 6, fig. 3; text-fig. 5) from the Upper Maastrichtian of Quiriquina Island, Chile (lectotype, here designated, the original of Steinmann 1895, pl. 6, fig. 3) has the following dimensions (after Steinmann):

	<i>D</i>	<i>Wb</i>	<i>Wh</i>	<i>Wb:Wh</i>	<i>U</i>
Lectotype	285(100)	112(39.2)	145(50.9)	0.77	51(17.9)
Paralectotype	239(100)	110(46)	120(50.2)	0.91	40(16.7)

The style of ornament is identical to that of *A. fresvillensis*, and there are, according to Steinmann, eleven umbilical tubercles and forty to forty-five ventral ribs as opposed to thirteen to fifteen umbilical tubercles and forty-eight ventral ribs in *fresvillensis*. An examination of the lectotype of *fresvillensis* shows identical ornament in both form and density, although the lectotype of *quiriquinae* is more compressed (*Wb:Wh* ratio is 0.77 vs. 0.94). I regard them as conspecific.

P. supremus Pethö, 1906 (p. 88, pl. 5, fig. 1) is also a macroconch *fresvillensis*; it is from the Maastrichtian of Fruska Gora, Yugoslavia. The sketchily figured Brazilian *P. sumneri*, *P. poseidon*, and *Canadoceras riogramense* of Maury (1930) may belong here, but they are scarcely recognizable from the figures; they are Maastrichtian in age. *P. subrobustus* (Seunes, 1891) (p. 15, pl. 13 (2), fig. 1) is immediately distinguished by its evolute coiling, coarse ribs, and lack of umbilical bullae/spines. *A. wittekindi* (Schlüter, 1872) (see Blaszkiewicz 1980, p. 50, pl. 42, figs. 1 and 2; pl. 43, fig. 2; pls. 44–47; pl. 48, figs. 3 and 4; pl. 49, figs. 1 and 3; pl. 50, figs. 2 and 3; pls. 51–53) and *A. vistulensis* Blaszkiewicz, 1980 (p. 48, pl. 42, figs. 3 and 4; pl. 43, figs. 1 and 3; pl. 48, figs. 1 and 2) both have much more coarsely ribbed nuclei than the present form, while *P. wittekindi* has a middle feebly ribbed and an adult strongly ribbed growth stage and *P. vistulensis* a strongly ribbed adult stage, all features which immediately distinguish them from the present species.

P. auritocostatus of Seunes (1890b, p. 239, pl. 8, fig. 4) *non* Schlüter, a diminutive bituberculate form that occurs with *A. fresvillensis* at the Carrière des Bernes between Gan and Rebenacq in the Pyrénées-Atlantiques, may be the microconch of this species; I have, however, failed to locate the original specimen and can do no more than suggest the possibility.

Occurrence. Upper Maastrichtian of the Cotentin and Pyrénées-Atlantiques, France; the Maastricht area, Holland; Denmark, Yugoslavia, Armenia, southern India, Madagascar, Western Australia, Chile, and Brazil (?).

EXPLANATION OF PLATE 8

Figs. 1–3. *Anapachydiscus fresvillensis* (Seunes, 1890a), BMNH C524 (*ex* Museum of Practical Geology Collections), 'Inf. Oolite', but from Upper Maastrichtian Calcaire à *Baculites* of Cotentin Peninsula, Manche, France; mentioned by Spath (1921, p. 265) as *Parapachydiscus colligatus*, $\times 1$.



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Superfamily HOPLITACEAE H. Douvillé, 1890

[*nom. correct* Wright and Wright 1951, p. 21, *pro* Hoplitida Spath, 1922b, p. 95, *nom. transl. ex* Hoplitidae Douvillé, 1890]

Family PLACENTICERATIDAE Hyatt, 1900

[= Hypengonoceratinae Chiplonkar and Ghare, 1976, p. 2; Baghiceratinae Chiplonkar and Ghare, 1976, p. 3]

Genus HOPLITOPLACENTICERAS Paulcke, 1906 (ICZN name no. 1348)

[= *Dechenoceras* Kayser, 1924, p. 175]

Type species. *Hoplites-Placenticeras plasticus* Paulcke, 1906, p. 186: ICZN Opinion 554, 1959: name no. 1629.

Discussion. See Kennedy and Wright (1983, p. 870) for diagnosis and occurrence of this genus.

Hoplitoplacenticeras lasfresnayanum (d'Orbigny, 1841)

Plate 9, figs. 4–6; text-fig. 10b

1841 *Ammonites lasfresnayanus* d'Orbigny, p. 326, pl. 97, figs. 3–5.

1850 *Ammonites lasfresnayanus* d'Orbigny, p. 212.

1894 *Hoplites lasfresnayi* d'Orbigny sp.; de Grossouvre, p. 121, pl. 23, fig. 4.

1925 *Hoplites Lasfresnayanus* d'Orbigny; Diener, p. 176.

1965 *Hoplitoplacenticeras lasfresnayanum* (d'Orbigny); Howarth, p. 391.

Holotype. By monotypy, SP unreg., the original of d'Orbigny (1841, p. 326, pl. 97, figs. 3–5), from Fresville.

Dimensions

	<i>D</i>	<i>Wb</i>	<i>Wh</i>	<i>Wb: Wh</i>	<i>U</i>
Holotype c	42.4(100)	14.6(34.4)	19.2(45.3)	0.76	10.0(23.6)

Description. The holotype and only known specimen is an internal mould with half a whorl of body-chamber. Coiling moderately involute on inner whorls, becoming more evolute on last half whorl, suggesting maturity. Umbilicus small (23.6% of diameter at maximum) and shallow, with flattened, outwards-sloping wall.

Umbilical shoulder sharply and narrowly rounded. Whorl section compressed with greatest breadth at umbilical shoulder; whorl breadth to height ratio 0.76. Inner flanks rounded; outer flanks flattened, converging to narrow venter that is flattened intercostally with narrowly rounded ventrolateral shoulders.

Sixteen small, sharp umbilical bullae on outer whorl. On phragmocone and early body-chamber these give rise to broad, flat-topped, rapidly expanding, flexuous, prorsiradiate primary ribs, each of which is separated by a narrow, deep interspace from a similarly broad and flat-topped secondary rib, inserted well below mid-flank. Each rib terminates in small outer ventrolateral clavus, while corresponding if small ventral clavus is also present (Pl. 9, fig. 6). Venter between smooth and sulcate with clavi on opposite sides slightly offset to opposite but not alternate.

EXPLANATION OF PLATE 9

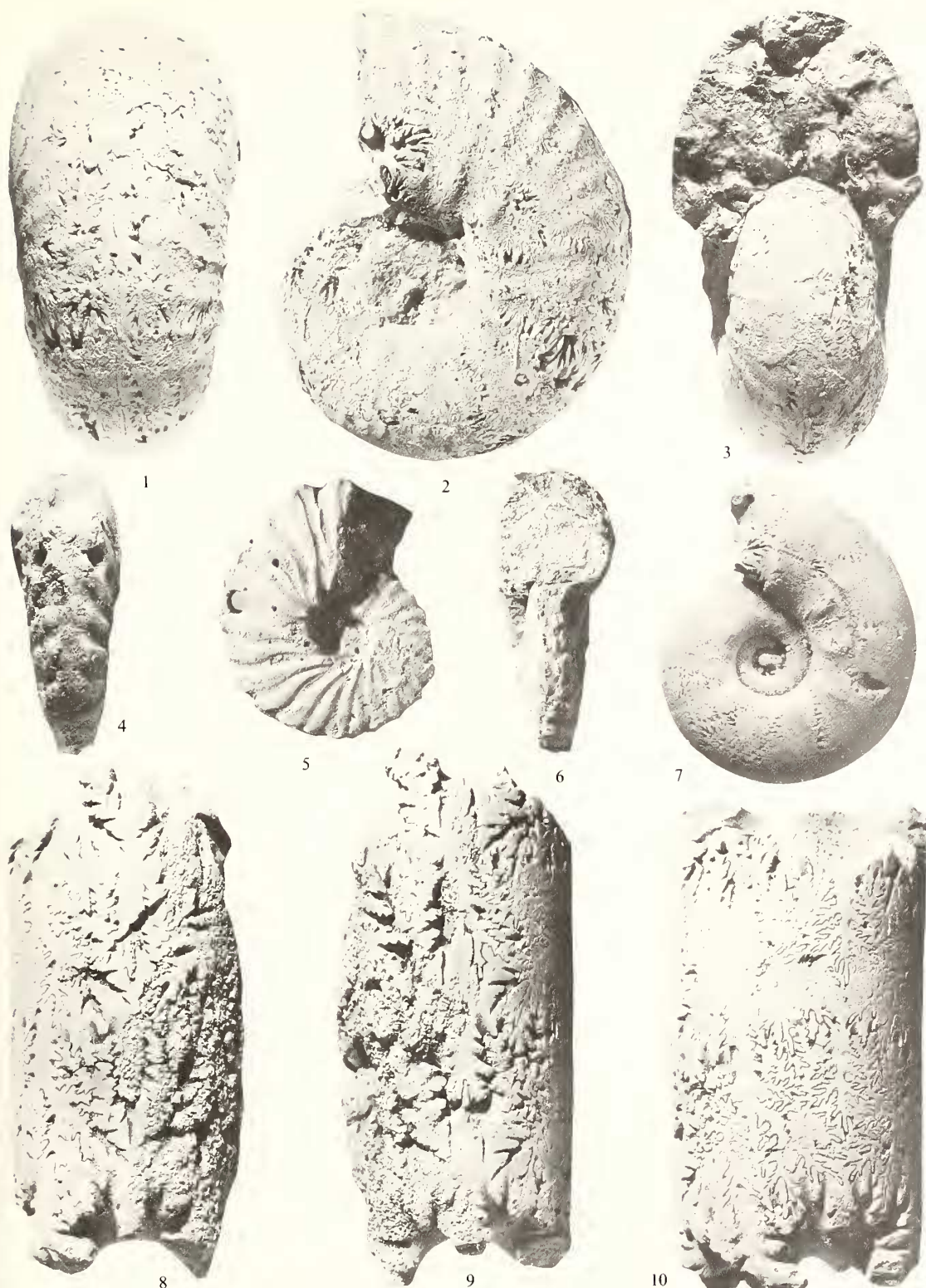
Figs. 1–3. *Anapachydiscus fresvillensis* (Seunes, 1890a), BMNH C524 (*ex* Museum of Practical Geology Collections), inner whorls, 'Inf. Oolite', but from Upper Maastrichtian Calcaire à *Baculites* of the Cotentin Peninsula.

Figs. 4–6. *Hoplitoplacenticeras lasfresnayanum* (d'Orbigny, 1841), SP unreg., holotype, from Fresville.

Fig. 7. *Pachydiscus* (*Pachydiscus*) *jacquoti* Seunes, 1890a, EMP unreg., syntype, from Fresville; original of Seunes (1890a, pl. 3 (2), fig. 3).

Figs. 8–10. *Diplomoceras cylindraceum* (Defrance, 1816), MNHP d'Orbigny Collection no. 7203, from Ste Colombe.

All from Upper Maastrichtian Calcaire à *Baculites* of Manche, France. All $\times 1$.



KENNEDY, *Anapachydiscus*, *Hoplitoplacenticeras*, *Pachydiscus* (*Pachydiscus*),
Diplomoceras

Ribbing irregular on last quarter whorl of body-chamber, with irregular non-bullate primaries and intercalated secondaries. Ventrolateral and ventral clavi have merged into a single clavus and there is irregular spacing and development of this tubercle suggesting minor pathological disturbance of ornament.

Suture incompletely exposed (text-fig. 10B) with moderately subdivided lobes and saddles; L asymmetrically bifid to subtrifid; L/U₂ asymmetrically bifid, U₂ small.

Discussion. *Ammonites lasfresnayanus* is referred to *Hoplitoplacenticer* on the basis of the ribbing and presence of outer ventrolateral and ventral tubercles, which recall in several respects the style seen in the type species, *H. plasticum* Paulcke, 1906. It differs from all other *Hoplitoplacenticer* in the very simple suture, without the multiplication of adventive and auxiliary elements so typical of the main stream of the genus. In terms of ornament it is closest to *H. marroti* (Coquand, 1859) (de Grossouvre 1894, p. 118, pl. 8, fig. 3; pl. 9, figs. 2 and 3) which has more numerous, narrower, rounded rather than flattened ribs and stronger tubercles, and *H. dolbergensis* (Schlüter, 1876) (p. 159, pl. 44, figs. 1-4) which has rather similar (if coarser) tubercles but ribs that loop between umbilical bullae and inner ventrolateral clavi (see also Giers 1964, pl. 6, figs. 2-7).

The suture line is not typical of *Hoplitoplacenticer* nor of the Placenticeratidae as a whole; its simplicity recalls that of ancestral Hoplitidae. This apart, I see no reason for not referring it to *Hoplitoplacenticer*, which is otherwise restricted to the Upper Campanian (*vide* Howarth 1965).

Occurrence. As for holotype.

Suborder ANCYLOCERATINA Wiedmann, 1966
Superfamily TURRILITACEAE Gill, 1871
[= Diplomocerataceae Brunschweiler, 1966, p. 14]

Family DIPLOMOCERATIDAE Spath, 1926
[= Neocrioceratinae Spath, 1953, p. 17]

Subfamily DIPLOMOCERATINAE Spath, 1926
[= Scalaritinae Ward, 1976, p. 455]

Genus GLYPTOXOCERAS Spath, 1925
[= *Neohamites* Brunschweiler, 1966, p. 48]

Type species. *Hamites rugatus* Forbes, 1846a, p. 117, by original designation.

Glyptoxoceras sp.

Material. FSR unreg., from Orglandes.

Description. The specimen is a fragment only, 14.5 mm long with maximum whorl height of 5 mm. Whorl section compressed oval (Wb:Wh = 0.8) with rib index 3.0-3.5. Ribs coarse and distant, strongly prorsiradiate on flanks, passing straight across venter but flexed forwards and convex on dorsum.

Sutures not seen.

Discussion. This enigmatic, straight, coarsely ribbed fragment is referred to *Glyptoxoceras* by comparison with coarse-ribbed species such as *G. largesulcatum* (Forbes, 1846a). It could conceivably be a *Phylloptychoceras* Spath, 1953, but those specimens of this genus I have studied are ornamented by broad bulges rather than the clearly differentiated ribs of the present form. *Glyptoxoceras* species occur in the Upper Maastrichtian of Kunraed in the Maastricht area, and the present occurrence is not unexpected.

Occurrence. As for material.

Genus DIPLOMOCERAS Hyatt, 1900

[= *Eudiplomoceras* Brunnenschweiler, 1966, p. 18]*Type species. Baculites cylindracea* Defrance, 1816, p. 160, by original designation.*Occurrence.* Maastrichtian of western and central Europe, the transcaucasian region of the USSR, Greenland, Zululand, Madagascar, southern India, Japan, Alaska, British Columbia, California, Antarctica, South America, New Zealand, and Australia.*Diplomoceras cylindraceum* (Defrance, 1816)

Plate 4, figs. 1 and 2; Plate 9, figs. 8–10; Plate 10; text-figs. 3I–L, 6, 7G–M

- 1816 *Baculites cylindracea* Defrance, p. 160.
- 1817 *Baculites gigantea* Desmarest, p. 47, pl. 1, figs. 1 and 2.
- 1825–1827 *Hamites cylindricus* Blainville, p. 382, pl. 23, fig. 1.
- 1842 *Hamites cylindraceus* D'Orbigny, p. 551, pl. 136, figs. 1–4.
- ?1846b *Hamites elatior* Forbes in Darwin, p. 265.
- 1847 *Hamites hampeanus* Hauer, p. 75.
- 1851–1856 *Hamites* . . . Woodward, p. 65, fig. 58.
- 1858 *Hamites cylindraceus* Defr. sp.; Hauer, p. 8, pl. 1 (2), figs. 3–6.
- 1861 *Hamites cylindraceus*, d'Orbigny; Binkhorst, p. 36, pl. 5b, figs. 5–7 (with additional early synonymy).
- 1869 *Hamites cylindraceus*, Defrance, sp.; Favre, p. 26, pl. 7, fig. 1.
- 1872 *Hamites* cf. *cylindraceus* Defr. sp.; Schlüter, p. 103, pl. 31, figs. 10–14; pl. 29, figs. 8 and 9.
- 1873 *Hamites cylindraceus* Defr. sp.; Redtenbacher, p. 130.
- ?1890 *Hamites elatior* Forbes?, White, p. 13, pl. 2, figs. 1 and 2.
- 1891 *Hamites cylindraceus* Defr. sp.; Böhm, p. 51.
- ?1895 *Hamites (Anisoceras) indicus* Forbes; Kossmat, p. 129 (33) (*pars*), pl. 19 (5), fig. 8 only.
- 1898 *Pachydiscus* sp. Mariani, p. 56 (6), pl. 8 (1), fig. 5.
- 1898 *Hamites* cf. *cylindraceus* Defr. sp.; Mariani, p. 57.
- ?1901 *Hamites* aff. *cylindraceus* Defrance sp.; Imkeller, p. 53.
- 1902 *Hamites cylindraceus* Defrance; Ravn, p. 249.
- 1903 *Hamites elatior* Forbes; Weller, p. 418, pl. 2, fig. 3.
- 1903 *Hamites* sp. Weller, p. 418, pl. 2, fig. 4.
- 1903 *Diplomoceras notabile* Whiteaves, p. 335, pl. 44, fig. 4.
- 1909 *Anisoceras notabile* Whiteaves; Kilian and Reboul, p. 15 (*pars.*), pls. 2 and 3; ?pl. 4; ?pl. 6, fig. 1.
- 1913 *Hamites cylindraceus* Defrance sp.; Nowak, p. 382, pl. 41, fig. 10; pl. 43, fig. 35; pl. 45, fig. 47.
- ?1930 *Glyptoxoceras parahybense* Maury, p. 185, pl. 11, fig. 2.
- 1938 *Diplomoceras cylindraceum* Defrance; Collignon, p. 56.
- 1951 *Diplomoceras* cf. *cylindraceum* (Defrance); Mikhailov, p. 41, pl. 2, figs. 9 and 10; text-fig. 10.
- 1951 *Diplomoceras cylindraceum* Defr. var. *lvovensis* var. nov., Mikhailov, p. 42, pl. 2, figs. 7 and 8; text-fig. 11a, b.
- 1952 *Diplomoceras notabile* Whiteaves, 1903; Usher, p. 109, pl. 29, fig. 2; pl. 30, fig. 1; pl. 31, figs. 26 and 27.
- 1953 *Hamites cylindraceus* Defrance; Petković, p. 33, pl. 6, figs. 1, 4–6.
- 1953 *Diplomoceras lambi* Spath, p. 17, pl. 2, figs. 1–3; pl. 3, fig. 1.
- 1953 *Diplomoceras cylindraceum* (Defrance in d'Orbigny); Spath, p. 17.
- 1953 *Diplomoceras notabile* Whiteaves; Spath, p. 17, pl. 2, fig. 4.
- ?1958 *Diplomoceras jimboi* Anderson, p. 199, pl. 68, fig. 5.
- ?1958 *Diplomoceras oshaughnessyi* Anderson, p. 201, pl. 56, fig. 2.
- 1959 *Diplomoceras cylindraceum* (Defrance); Naidin and Shimanskij, p. 181, pl. 3, fig. 2.
- 1962 *Diplomoceras (Diplomoceras)* cf. *notabile* Whiteaves; Wiedmann, p. 208.
- 1963 *Diplomoceras notabile* Whiteaves; Jones, p. 32, pl. 21, fig. 1; text-fig. 15.
- 1964 *Diplomoceras cylindraceum* (Defrance); Tsankov, p. 152, pl. 4, fig. 2.
- ?1965 *Diplomoceras* sp. Birkelund, p. 67, pl. 16, figs. 1 and 2.
- 1966 *Eudiplomoceras ragmati* Brunnenschweiler, p. 18, pl. 8, fig. 7; text-figs. 4 and 5.
- 1966 *Diplomoceras* cf. *notabile* (Whiteaves, 1903); Brunnenschweiler, p. 20, pl. 7, fig. 3; text-fig. 6.

- 1966 *Diplomoceras notabile* (Whiteaves, 1903); Brunnschweiler, text-fig. 7.
 ?1970 *Diplomoceras* sp. Henderson, p. 27, pl. 3, fig. 5.
 1971 *Diplomoceras notabile* Whiteaves; Collignon, p. 11, pl. 644, figs. 2377–2379.
 1976 *Diplomoceras lamibi* Spath; Del Valle and Rinaldi, p. 1, pls. 1–10.
 1976 *Diplomoceras cylindraceum* Defrance; Klinger, p. 81 et seq.
 1976 *Diplomoceras* gr. ex. *lamibi* Spath; Klinger, p. 82.
 1976 *Diplomoceras* gr. ex. *cylindraceum* Defrance; Klinger, p. 82.
 1976 *Diplomoceras* (*Diplomoceras*) *notabile* Whiteaves, 1903; Klinger, p. 82, pl. 34, figs. 2 and 4.
 1979 *Diplomoceras cylindraceum* (Defrance, 1816); Birkelund, p. 55.
 1980 *Diplomoceras cylindraceum lyvensis* Mikhailov, 1951; Blaszkiewicz, p. 30, pl. 54, fig. 4.
 1980 *Diplomoceras cylindraceum cylindraceum* (Defrance, 1916 [*sic*]); Blaszkiewicz, p. 30, pl. 54, fig. 2; pl. 55, figs. 6 and 7.
 1982 *Diplomoceras cylindraceum* (Defrance, 1822); Tsankov, p. 22, pl. 6, figs. 1–3.
 ?1982 *Diplomoceras notabile*? Whiteaves; Martinez, p. 168, pl. 29, fig. 6.

Type. Defrance (1816, p. 160) described the species as follows: 'Cette espèce est cylindrique. Ses cloisons sont très profondément découpées. Son test est sillonné transversalement, et l'on voit à l'extérieur une trace longitudinale qui est sans doute celle du siphon. Le plus grand morceau de cette espèce que j'ai vu, a dix-neuf décimètres (sept pouces) de longueur, sur quarante millimètres (dix-huit lignes) de diamètre à sa base, et il est tronqué par le deux bouts. Elle se trouve avec la précédent; mais elle est beaucoup plus rare.'

'La précédent' is 'La Baculite vertébrale, foss. de Maastricht'. This is a perfectly valid diagnosis and the species dates from Defrance, rather than d'Orbigny (1842) as some authors suggest. It is also clear that the locality Maastricht is given for the species. Defrance's specimens, or those he studied, have not been traced. A neotype will be designated in my revision of the type Maastrichtian (in prep.).

Material. BMNH C6410b (the original of Woodward 1851–1856, p. 96, fig. 58; p. 210, fig. 65), BMNH C37027 (ex Tesson Collection, mentioned by Spath 1953, p. 17), both from Fresville; BMNH 48763, without precise locality data, C70643 and C70644 (ex J. Sowerby, ex de Gerville Collection) from Valognes; MHNG, six unregistered specimens from Valognes; NHMW 7479 from Orglandes; FSR 4–6 from Ste Colombe; EMP unreg., unlocalized (two specimens); MNHP R1204 (ex de Vibraye Collection, 1896–1927) from Valognes, R1203 from Golleville, R1206 from Fresville; MNHP d'Orbigny Collection 7203 from Ste Colombe.

Dimensions

	<i>Wb</i>	<i>Wh</i>	<i>Wb: Wh</i>
BMNH 48763	19.9	21.9	0.91
	23.5	26.2	0.90
NHMW 7479	22.3	25.0	0.89
MHNG unreg.	23.1	25.9	0.89
BMNH 37027	28.2	30.7	0.92
	35.0	38.5	0.91
MHNG unreg.	28.8	29.0	0.99
	33.5	36.5	0.92
MHNG unreg.	47.0	48.5	0.97
FSR 5	42.5	44.0	0.97
FSR 6	42.5	44.5	0.96
FSR 4	51.0	52.0	0.98

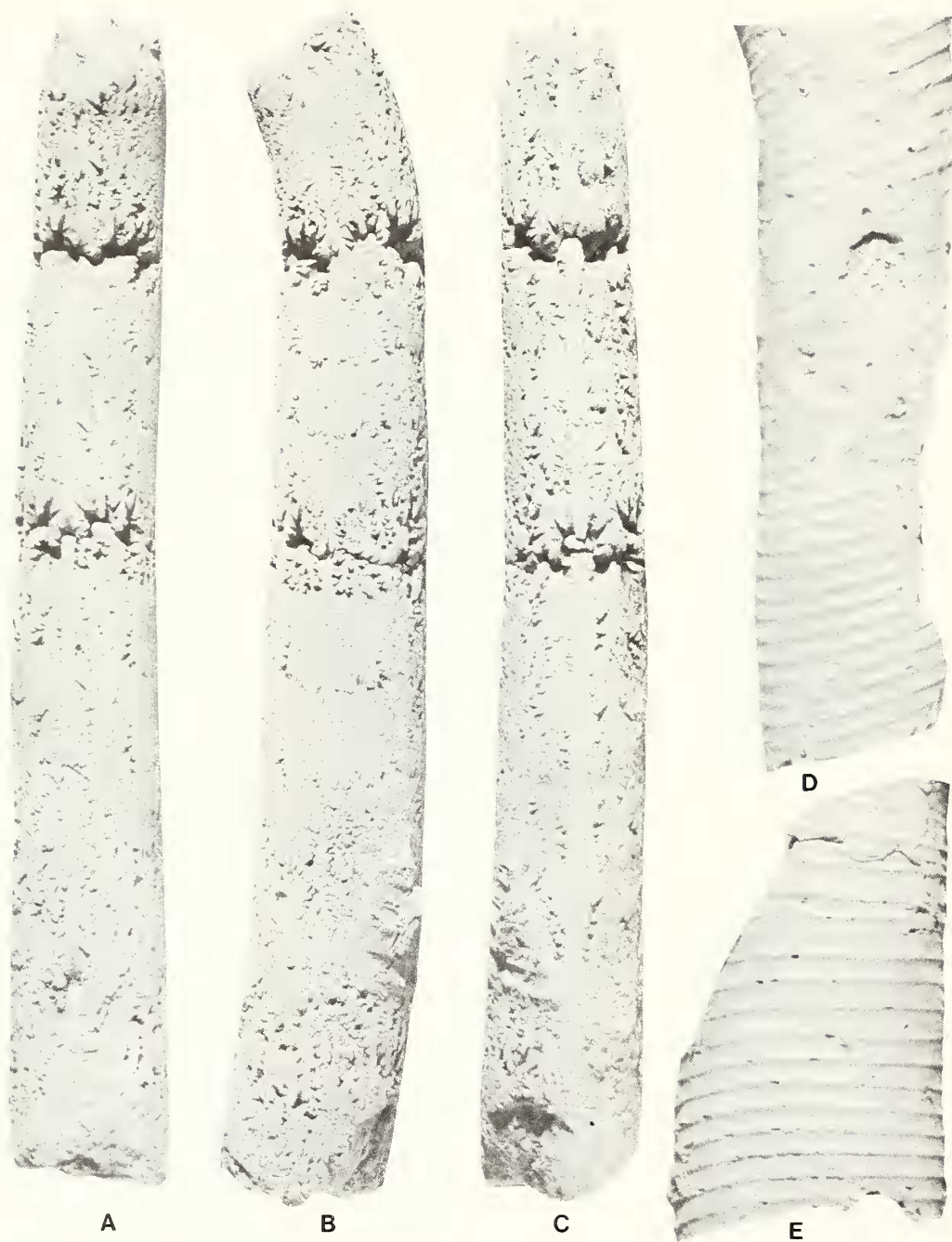
Description. All material is in form of septate internal moulds; a few have traces of external ornament and there is a single external mould. The material consists of fragments of straight, slowly expanding shafts and associated

EXPLANATION OF PLATE 10

Figs. 1–4. *Diplomoceras cylindraceum* (Defrance, 1816), from Upper Maastrichtian Calcaire à *Baculites* of Fresville, Manche, France. 1 and 2, BMNH 6410b; original of Woodward (1851–1856, p. 96, fig. 58; p. 201, fig. 65) and mentioned by Spath (1953, p. 17). 3 and 4, BMNH 37027 (ex Tesson Collection); mentioned by Spath (1953, p. 17).

All $\times 1$.





TEXT-FIG. 6. *Diplomoceras cylindraceum* (Defrance, 1816). A-C, BMNH 48763 (*ex* Bright Collection), by its preservation, from Upper Maastrichtian Calcaire à *Baculites* of the Cotentin Peninsula, Manche, France; specimen shows particularly strong ornament for internal mould of this species. D, E, BMNH C376, silicone squeeze taken from external mould, showing external ornament of part of two limbs of the same specimen; compare with text-fig. 8. All figures natural size.

curved portions that show shell to have consisted of at least two subparallel shafts, possibly three. Smallest specimen has whorl height of 21.9 mm and is part of curved portion; largest, straight portion has whorl height of 51 mm.

As can be seen from table of dimensions, whorl section varies from compressed to near equidimensional, with whorl breadth to height ratio of 0.89 to 0.99. Sections vary from oval with venter only slightly narrower than dorsum to distinctly ovoid/rounded subtrigonal to nearly circular. Internal moulds vary from virtually smooth (Pl. 4, figs. 1 and 2; Pl. 9, figs. 8–10) to faintly (Pl. 10, figs. 3 and 4) to distinctly (if subduedly) ribbed (text-fig. 6A–C). Rib direction on straight portions varies from almost rectiradial (Pl. 10, figs. 3 and 4) to markedly prorsiradial (text-fig. 6A–C) even on same specimen (text-fig. 6D, E). It varies from prorsiradial to rectiradial around hooks.

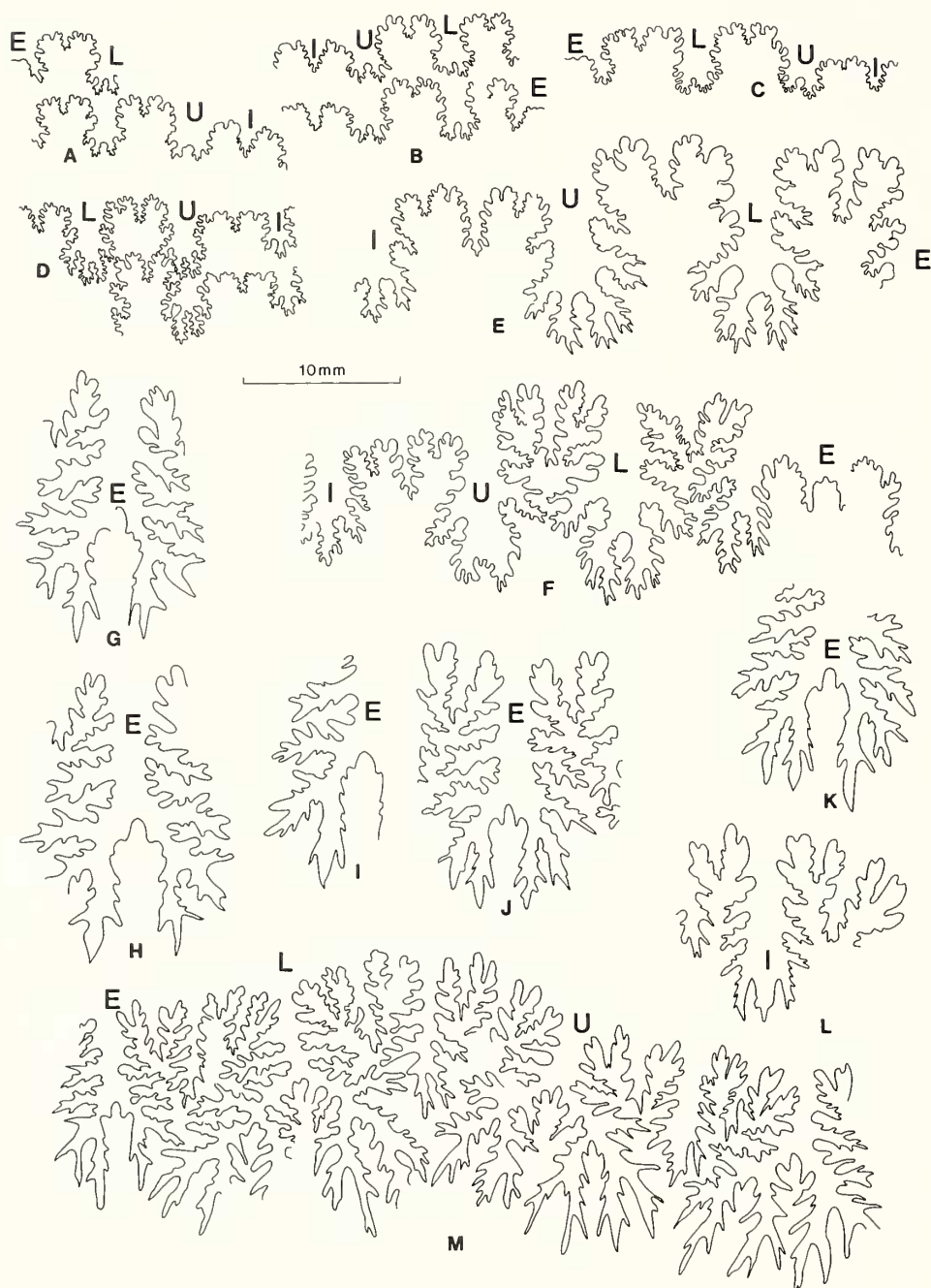
Where external ornament is preserved, ribs are annular, narrow, sharp, and separated by much wider interspaces (text-fig. 6D, E; Pl. 10, fig. 3); rib index varies from 11 to 13 on one specimen and between the three specimens where ornament was visible. Occasional feeble grooves on moulds appear to be strengthened interspaces or incipient constrictions. There are also distinct rugations on surface corresponding to apertural end of sutures in some specimens.

Suture line is deeply and intricately subdivided (text-fig. 7G–M).

Discussion. As described here, the Calcaire à *Baculites* material is characterized by a variable but never depressed ovoid/rounded to subtrigonal to nearly circular whorl section and a rib index of 11 to 13 on the three specimens where this was measurable. *D. cylindraceum lvoense* Mikhailov, 1951 (p. 42, pl. 2, figs. 7 and 8; text-fig. 11a, b), the holotype of which is the original of Nowak (1913, p. 382, pl. 41, fig. 10) co-occurs with such forms in several parts of Europe, and is here regarded as a synonym. Mikhailov's figure (1951, text-fig. 11a, b) shows a distinctly compressed, ovoid section, but this is due to post-mortem deformation. The rib index (16–17) is higher than the material described here but the Cotentin sample is so small that this is not considered significant.

I can see even less difference between *D. cylindraceum* and the Antarctic *D. lambi* Spath, 1953 (p. 17, pl. 2, figs. 1–3). Spath differentiated them (so far as one can judge) on whorl section, compressed in *cylindraceum* and circular in *lambi*, and details of suture. On examining the BMNH type series, moulds of phragmocones are smooth to faintly ribbed, but moulds of body-chambers bear strong ribs. The rib direction varies as in the French material. The whorl breadth to height ratio of eight uncrushed specimens varied from 0.95 to 1.06, with five specimens slightly compressed and four slightly depressed. The rib index, measurable on only three specimens, was 13, 14, and 17. *D. notabile* Whiteaves, 1903 (p. 335, pl. 44, fig. 4; holotype refigured by Usher 1952, pl. 29, fig. 2) has, according to Whiteaves, a whorl breadth to height ratio of 0.8 at a whorl height of 47 mm and 0.84 at 55 mm, thus being more compressed than any of the present specimens, and with a slightly higher rib density. BMNH C3486 and C41424 had whorl breadth to height ratios of 0.87 and 0.90 and rib indices of 14 and 12 respectively. Alaskan examples (Jones 1963, p. 32, pl. 21, fig. 1) have whorl breadth to height ratios of 0.80 to 0.89 and rib indices of 11 or 12. Usher was impressed by the sutural differences between *D. cylindraceum*, as illustrated by d'Orbigny, and *D. notabile*, pointing to the greater degree of incision in the Canadian form, especially the degree of incision of the external saddle. It is, at most, subspecifically distinct. *Hamites elatior* Forbes, 1846b is based on an inadequate description, the types being lost. *H. hampeanus* Hauer, 1847 is a clear synonym, as Hauer pointed out in 1858 (p. 8, pl. 1, figs. 3–6). The *H. elatior* of White (1890, p. 13, pl. 2, figs. 1 and 2) has a compressed, parallel-sided whorl section and a rib index of 20, but White states it to be crushed. It resembles the finely ribbed specimens of Kilian and Reboul (1909, pl. 4) and Weller (1903). *Eudiplomoceras raggati* Brunnenschweiler, 1966 (p. 18, pl. 8, fig. 7; text-figs. 4 and 5) is a further synonym. The inadequately described *D. jinboi* and *D. oshaugnessyi* of Anderson (1958) are doubtfully referred to the present species. *D. australe* Hunicken, 1965 (p. 67, pl. 4, figs. 1–4) has a whorl breadth to height ratio of up to 1.6 and seems distinct enough on this criterion.

Occurrence. This species ranges throughout most of the Maastrichtian. The precise Danish records of Birkelund (1979, text-fig. 1) show it first appearing low in the *Belemnella lanceolata* Zone and extending to the top of the *B. casimirovensis* Zone. It has a world-wide distribution, with records from north-west France, northern Spain (?), Italy, Holland, Denmark, north Germany, Poland, Austria, the USSR, southern India (?), Zululand,



TEXT-FIG. 7. Sutures. A-C, *Baculites anceps* Lamarck, 1822, all MHNG unreg. (Pictet Collection). D-F, *B. vertebralis* Lamarck, 1801: D, BMNH C70592; E, MHNG unreg. (Pictet Collection); F, NHMW 7460. G-M, *Diplomoceras cylindraceum* (DeFrance, 1816): G-I, MHNG unreg. (Pictet Collection); J, K, BMNH 37027; M, NHMW 7479.

Madagascar, Australia, New Zealand (?), the Antarctic, South America, California, British Columbia, Alaska, and Greenland (?).

Family BACULITIDAE Gill, 1871

[= Eubaculitinae Brunnenschweiler, 1966, p. 4]

Genus BACULITES Lamarck, 1799

[= *Homaloceratites* Hupsch, 1768, p. 110 (*non binomen*); *Euhomaloceras* Spath, 1926, p. 80]

Type species. *Baculites vertebralis* Lamarck, 1801, p. 103, by subsequent designation of Meek (1876, p. 391).

Discussion. See Kennedy (1984a) for recent diagnosis and discussion of the genus.

Baculites vertebralis Lamarck, 1801

Plate 11, figs. 6–11; Plate 12, figs. 1–6; text-figs. 3A–D, 7D–F, 8

- 1742 Spendylolitte Bourguet, p. 74, pl. 49, figs. 313–316.
 1768 *Homaloceratites* Hupsch, p. 110, pl. 4, figs. 11, 15, 18, 19 (*non binomen*).
 1799 Corne d'ammon droite . . . Faujas-Saint-Fond, p. 140, pl. 21, figs. 2 and 3.
 1801 *Baculites vertebralis* Lamarck, p. 103.
 1817 *Baculites vertebralis* Lamarck; Desmarest, p. 49, pl. 2, figs. 7 and 8.
 1822 *Baculites Faujasii* Lamarck, p. 647.
non 1825 *Baculites vertebralis* Lamarck; Blainville, p. 380, pl. 12, figs. 1–3.
non 1828 *Baculites faujasi* J. de C. Sowerby, p. 186, pl. 592, fig. 1.
 ?1850 *Baculites Faujasii* Lamarck; Alth, p. 208, pl. 10, figs. 33–36.
 1861 *Baculites faujasi*, Lamarck; Binkhorst, p. 40, pl. 5d, fig. 1 (with extensive synonymy).
 1876 *Baculites vertebralis* Lam.; Schlüter, p. 143 (*pars*), pl. 39, figs. 12 and 13, *non* fig. 11; pl. 40, figs. 4 and 5, *non* fig. 6.
 ?1901 *Baculites vertebralis* Lam. (Schlüter); Imkeller, p. 54.
 1902 *Baculites vertebralis* Lamarck; Ravn, p. 250.
 1907 *Baculites vertebralis* Lamarck; Pervinquière, p. 92 (*pars*), *non* pl. 4, fig. 9.
 1908 *Baculites vertebralis* Lamarck; Nowak, p. 346, pl. 14, fig. 8.
 1925 *Baculites vertebralis* Lamarck; Diener, p. 64 (*pars*) (with synonymy).
 1951 *Baculites vertebralis* Lamarck; Mikhailov, p. 48, pl. 1, figs. 4–6.
non 1964 *Baculites vertebralis* Lam.; Giers, p. 256, text-figs. 1 and 2.
 1965 *Baculites vertebralis* Lamarck; Howarth, pp. 363 and 368.
 1979 *Baculites vertebralis* Lamarck, 1801; Birkelund, p. 53.

Types. *B. vertebralis* was introduced by Lamarck in 1801 without description, but with reference to the figures of Faujas-Saint-Fond (1799, p. 141, pl. 21, figs. 2 and 3) and Bourguet (1742, pl. 49, figs. 313–316). The original of Faujas-Saint-Fond's pl. 21, figs. 2 and 3, is herein designated lectotype of the species. It is the holotype, by monotypy, of *B. faujasi* Lamarck, 1822 (p. 647).

Material. BMNH C70591–C70593 from Valognes (*ex* J. Sowerby, *ex* de Gerville Collection); NHMW 7460 from Fresville (? *ex* de Gerville Collection); MNHG, three unregistered specimens (*ex* Pictet Collection).

Dimensions

	<i>Wb</i>	<i>Wh</i>	<i>Wb:Wh</i>
MHNG unreg.	21.0	37.0	0.57
NHMW 7460	17.0	32.0	0.53
	13.1	23.8	0.55
BMNH C70593	14.3	23.9	0.60
BMNH C70592	12.4	21.3	0.58

Description. All specimens are internal moulds. Medium-sized for genus, straight, slowly expanding, compressed, with whorl breadth to height ratio varying between 0.53 and 0.60. Whorl section oval with dorsum more broadly rounded than venter and sides markedly flattened. Five specimens studied are almost smooth

(text-fig. 8A-E) or ornamented by growth striae and feeble riblets (Pl. 11, fig. 7; Pl. 12, figs. 2 and 5). These are feebly convex and transverse on dorsum, sweep back into a marked concavity on dorsolateral area, and are projected strongly forwards on ventrolateral area, meeting line of venter at 30° and crossing venter in narrow convexity. These specimens show feeble longitudinal groove corresponding to position of umbilical lobe.

Two MHNG specimens show much stronger ornament (Pl. 11, figs. 9-11), with growth striae and riblets strengthened into concave, crescentic dorsolateral rib. In best-preserved specimen (Pl. 11, figs. 9-11) these are disturbed by series of pathological excrescences, but a rather worn specimen (not figured) shows 3.0-3.5 such ribs in a distance equal to whorl height. Irregular constrictions sometimes developed.

Suture (text-fig. 7D-F) relatively complex for genus, with deeply incised bifid elements. E/L and L/U tall, L narrow, U relatively broad, U/I squat.

Discussion. *B. vertebralis* is immediately distinguished from the other Calcaire à *Baculites* species, *B. anceps* Lamarck, 1822, by the oval rather than tear-shaped cross-section, by which they can be differentiated even as single camerae. The venter of *vertebralis* is rounded, that of *anceps* acute and flanked by grooves (Pl. 11, figs. 12-14; Pl. 12, figs. 7-11), while the growth lines and riblets of *anceps* intersect the line of the venter at a much smaller angle (compare Pl. 12, figs. 5 and 7); *anceps* also has much simpler, squat, little-incised sutural elements (compare text-fig. 7A-C and 7D-F). *B. faujasi* Lamarck, 1822 (p. 647) is an objective synonym, having the same type as *B. vertebralis*. *B. knorrianus* Desmarest, 1817 (p. 48, pl. 1, fig. 3) is a further species commonly recorded from the European Maastrichtian (synonymy in Diener 1925, p. 61; see also Birkelund 1979). I interpret it in terms of specimens from Nagorzany, Galicia (NHMW 7459a-c and BMNH 74030a-d). This is a very large species, with a whorl height of up to 80 mm in specimens I have seen. The whorl section is ovoid, with a broadly rounded venter (as in *B. vertebralis*) but with strongly convergent flanks and a narrower venter. Ornament is weak to obsolete in most specimens, but some show distinct to strong ventral ribbing and others ribs that extend on to the ventrolateral region. The suture is even more deeply and intricately subdivided than in *B. vertebralis*.

Although only a handful of *B. vertebralis* are known from the Calcaire à *Baculites*, it is of interest to note that individuals are mature at disparate sizes: BMNH C70592 (Pl. 12, figs. 1-3) shows approximated sutures at a whorl height of 19.5 mm whereas one of the MHNG specimens (Pl. 11, figs. 6-8) is still septate at a whorl height of 38.0 mm. The sample is, of course, too small to do anything but suggest the possibility of size dimorphism.

Occurrence. Calcaire à *Baculites*, Upper Maastrichtian of Valognes and Fresville, Manche, France. The type material is from the Upper Maastrichtian of St Pietersberg, Maastricht, where it is relatively common. It also occurs at localities such as Kunraed and elsewhere in Limburg and Hainault, in the Upper Maastrichtian of the Petites Pyrénées (Haute Garonne), in Denmark, southern Sweden, north Germany, Poland, the southern USSR, and Tunisia.

Baculites anceps Lamarck, 1822

Plate 11, figs. 12-14; Plate 12, figs. 7-11; text-figs. 3E-H, 7A-C

1822 *Baculites anceps* Lamarck, p. 648.

1885 *Baculites schlüteri*? Moberg, p. 40, pl. 4, fig. 13 only.

EXPLANATION OF PLATE 11

Figs. 1-5. *Pachydiscus* (*Pachydiscus*) *gollevillensis* (d'Orbigny, 1850). 1, 4, 5, SP unreg., from Golleville; inner whorls of original of Seunes (1891, pl. 14 (5), fig. 3). 2 and 3, MHNG unreg. (Pictet Collection), from Valognes.

Figs. 6-11. *Baculites vertebralis* Lamarck, 1801. 6-8, 9-11, MHNG unreg. (Pictet Collection), from Valognes. Figs. 12-14. *B. anceps* Lamarck, 1822, MHNG unreg. (Pictet Collection), from Valognes.

All from Upper Maastrichtian Calcaire à *Baculites* of Manche, France. All $\times 1$.



KENNEDY, *Pachydiscus* (*Pachydiscus*), *Baculites*



TEXT-FIG. 8. *Baculites vertebralis* Lamarck, 1801, from Upper Maastrichtian Calcaire à *Baculites* of Manche, France. A, B, NHMW 7460 from Fresville; C-E, BMNH C70591 (ex J. Sowerby, ex de Gerville Collection) from Valognes; all figures natural size.

- non 1963 *Baculites* cfr. *anceps* Lamarck, 1799; Young, p. 42, pl. 2, figs. 18, 20–22.
 non 1964 *Baculites anceps* (Lam.) emend. Nowak; Giers, p. 257, text-fig. 3.
 1965 *Baculites anceps* Lamarck; Howarth, p. 363, pl. 4, fig. 4; pl. 5, figs. 4 and 5; pl. 6, figs. 1–5; text-figs. 2, 3, 5–12 (with synonymy).
 non 1976 *Baculites anceps* Atabekian and Khakhimov, p. 94, pl. 2, figs. 3 and 4; pl. 11, figs. 8–10.
 1979 *Baculites valognensis* Boehm, 1891; Birkelund, p. 53.
 ?1982 *Baculites anceps* Lamarck; Martinez, p. 169, pl. 30, figs. 1 and 2.

Type. Neotype, designated by Howarth (1965, p. 365), is BMNH 32573 from 'Normandy' (ex Mantell Collection).

Material. The several hundred specimens in the repositories listed on p. 27 are not noted separately here. Localities given are 'Normandy', 'Manche', Fresville, Valognes, Ste Colombe, Picauville, Orglandes, Port Filiolet, Néhou, Bonneville, and Golleville.

Discussion. Howarth (1965) has provided a full and comprehensive description and discussion of *B. anceps*, to which the reader is referred. The characteristic features of the species are the tear-shaped whorl section (text-fig. 3E–11), the acute, sharp venter flanked by grooves (Pl. 11, fig. 12; Pl. 12, figs. 8 and 11), plus strongly projected ventrolateral ribbing such that the aperture possessed a very long rostrum. As with the material studied by Howarth, an examination of hundreds of specimens at all growth stages shows a predominance of feebly ornamented to near smooth individuals, some with lateral grooves, and a paucity of ribbed forms (Howarth 1965, pl. 6, fig. 1). Because there are so few examples with phragmocone and body-chamber associated it is difficult to assess the state of maturity of most specimens, but body-chambers reach a much larger size than those illustrated by Howarth; Plate 12, figs. 7 and 8 show the largest body-chamber seen which is incomplete at a whorl height of 34 mm. I would also note the marked curvature of some specimens (Pl. 11, fig. 13).

B. carinatus Binkhorst, 1861 (p. 43, pl. 5d, fig. 2) (not Morton) from Mont St Pierre, Maastricht, is an Upper Maastrichtian form with a curious, tear-shaped section and ventral ribs only. I was unable to find the holotype in the Binkhorst Collection during a visit to the Museum für Naturkunde, East Berlin, in December 1983. *B. valognensis* J. Böhm, 1891 (p. 50, pl. 1, fig. 13) is based on a fragment only from Siegsdorf, Oberbayern, and is best regarded as a *nomen dubium*. The specimens from the Calcaire à *Baculites* named *B. anceps valognensis* by Nowak (1908, p. 335, pl. 14, figs. 6 and 7; text-figs. 1–4 on p. 331 and 6, 7, 9, 12 on p. 337) are within the limits of this species, as Howarth noted. *B. a. leopoliensis* Nowak, 1908 (p. 328, pl. 14, figs. 1–5, 10, 11) is a much larger species with strong crescentic ribs on the flanks and persistent secondary ribs on the venter.

Occurrence. The careful records of Birkelund (1979, p. 53, as *B. valognensis*) show this species to be restricted to the Upper Maastrichtian in Denmark. In Limburg it occurs as a rarity in the Upper Maastrichtian of Kunraed, Geulhem, and at Maastricht. There are records from the Maastrichtian of the USSR and possibly Spain. The many Campanian records of the species are based on poor material, probably of other species of ribbed *Baculites*.

Genus FRESVILLIA gen. nov.

Type species. *F. constricta* gen. et. sp. nov. Upper Maastrichtian, Fresville, Manche, France.

Diagnosis. Baculitids with circular whorl section ornamented by strongly prorsiradiate growth striae and feeble riblets, periodically accentuated on the dorsolateral area into crescentic, concave ribs; strongly projected on lateroventral area where they may branch, and crossing venter in broad convexity; only slightly less strongly projected on dorsolateral area, crossing dorsum more or less transversely; interrupted by close or distant constrictions, best developed on venter. Suture moderately subdivided with triangular elements.

Discussion. The circular whorl section and periodic constrictions recall *Lechites* Nowak, 1908, of which the present form is a heterochronous homoeomorph. The two differ in that the growth lines are markedly prorsiradiate in *Fresvillia*, are markedly concave on the inner flank and accentuated into periodic crescentic ribs, whilst the riblets and striae branch over the venter. *Lechites* are much

more prominently ribbed, while the constrictions are well developed on flanks, dorsum, and venter. Direction of growth lines, style of ribs, and limitation of constrictions to the ventral region separate the new genus from *Sciponoceras* Hyatt, 1894.

A number of diplomoceratids have straight limbs to the shell and a circular section; these are *Polyptychoceras* Yabe, 1927, *Subptychoceras* Shimizu, 1935, and *Phylloptychoceras* Spath, 1953. All have ribs that are only feebly prorsiradiate, deep constrictions on the flanks, and simplified sutures. *Astreptoceras* Henderson, 1970 is a baculitid homoeomorph that also has only feebly prorsiradiate growth lines and ribs as well as annular constrictions.

The present form is referred to Baculitidae rather than Diplomoceratinae because of the typically baculitid form of the growth lines and its suture, which closely resembles that of baculitids and is not simplified as in *Polyptychoceras* and its allies. *F. constricta* sp. nov., although known from but a single specimen (which distinction it shares with several other Calcaire à *Baculites* ammonites) merits recognition. The origin of the type species lies in the older *B. teres* Forbes, 1846a (p. 115, pl. 10, fig. 5; Stoliczka 1866, p. 197, pl. 90, fig. 12 *non* 13; Matsumoto 1959, p. 163, pl. 45, figs. 5, 6 and text-figs. 82 and 83), which is also referred to *Fresvillia*. This has a circular whorl section and growth lines that are only a little less markedly prorsiradiate than the type species, differing in the closer spaced, regular constrictions. *B. lechitides* Brunnschweiler, 1966 (p. 23, pl. 1, figs. 1-3; text-fig. 8) may also belong here.

Occurrence. Lower Maastrichtian of southern India, California, and Alaska. Upper Maastrichtian of Fresville, Manche, France and possibly Western Australia.

Fresvillia constricta gen. et sp. nov.

Plate 14, figs. 39-42; text-fig. 10A

Holotype. IRSNB 10254 (*ex* Leriche Collection, I.G. 19859) from the Upper Maastrichtian Calcaire à *Baculites*, Fresville, Manche, France.

Diagnosis. *Fresvillia* with distant constrictions.

Description. Holotype and only known specimen (Pl. 14, figs. 39-42) an internal mould of part of the phragmocone and body-chamber with maximum whorl height 8.5 mm and length 47.0 mm. Straight, slowly expanding, with circular whorl section. Surface ornamented by growth striae and feeble riblets. Ornament effaced on dorsum, flexed back and strongly concave on dorsolateral area, periodically strengthened into crescentic ribs separated by a distance equal to three times median whorl height. Ribs and striae strongly prorsiradiate on flank, curving back and crossing ventrolateral region and venter in broad convexity, branching into groups of two or three with additional intercalatories of variable strength and looped over venter. Growth striae strongly projected on dorsolateral area, passing more or less straight across dorsum. Marked distant constrictions on ventrolateral and ventral region, effacing at mid-flank.

Suture (text-fig. 10A) with moderately subdivided bifid lobes and saddles with trigonal outline.

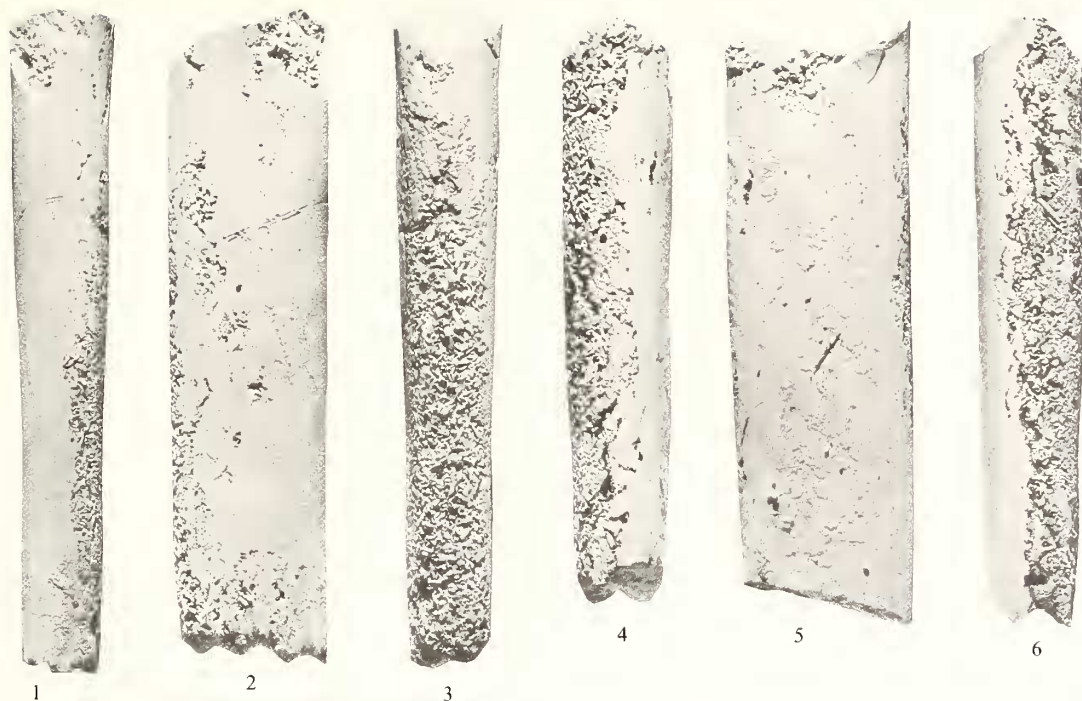
Discussion. *F. teres*, the second species referred to *Fresvillia*, has a similar whorl section and course of growth lines, which are only slightly less projected. It is easily separated by its close, even constrictions, quite different from the distant ones of *F. constricta*. The typically baculitid suture distinguishes *F. constricta* from fragments of the superficially homoeomorphous smoothing

EXPLANATION OF PLATE 12

Figs. 1-6. *Baculites vertebralis* Lamarck, 1801. 1-3, BMNH C70592 (*ex* J. Sowerby, *ex* de Gerville Collection). 4-6, BMNH C70593 (*ex* J. Sowerby, *ex* de Gerville Collection).

Figs. 7-11. *B. anceps* Lamarck, 1822. 7 and 8, NHMW 7482. 9-11, MHNG unreg. (Pictet Collection).

All from Upper Maastrichtian Calcaire à *Baculites* of Valognes, Manche, France. All $\times 1$.



diplomoceratids such as *Polyptychoceras*, *Phylloptychoceras*, *Astreptoceras*, and their allies, while cross-section, form of ribs, and constrictions separate it from all contemporaneous baculitids. Differences from the Albian–Cenomanian *Lechites* and Cenomanian–Turonian *Sciponoceras* are noted under the generic discussion.

Occurrence. As for type.

Superfamily SCAPHITACEAE Gill, 1871

[*nom. transl.* Wright and Wright 1951, p. 13 *ex* Scaphitidae Gill]

Family SCAPHITIDAE Gill, 1871

Subfamily SCAPHITINAE Gill, 1871

[*nom. transl.* Wright 1953, p. 473 *ex* Scaphitidae Gill]

Genus HOPLOSCAPHITES Nowak, 1911

[= *Mesoscaphites* Atabekjan, 1979, p. 523 (*nom. nud.*)]

Type species. *Ammonites constrictus* J. Sowerby, 1817, p. 189, pl. A, fig. 1, by original designation.

Diagnosis. See Birkelund (1965, p. 102).

Discussion. Early *Hoploscaphites* are distinct enough, but some of the later forms converge with some *Scaphites* Parkinson, 1811.

Occurrence. Upper Campanian to Upper Maastrichtian. Europe, Israel, Chile, Grahamland, USA, Canada, and Greenland.

Hoploscaphites constrictus (J. Sowerby, 1817)

Plate 13, figs. 1–13, 16–24; Plate 14, figs. 1–38; Plate 15; text-figs. 9, 11A–H

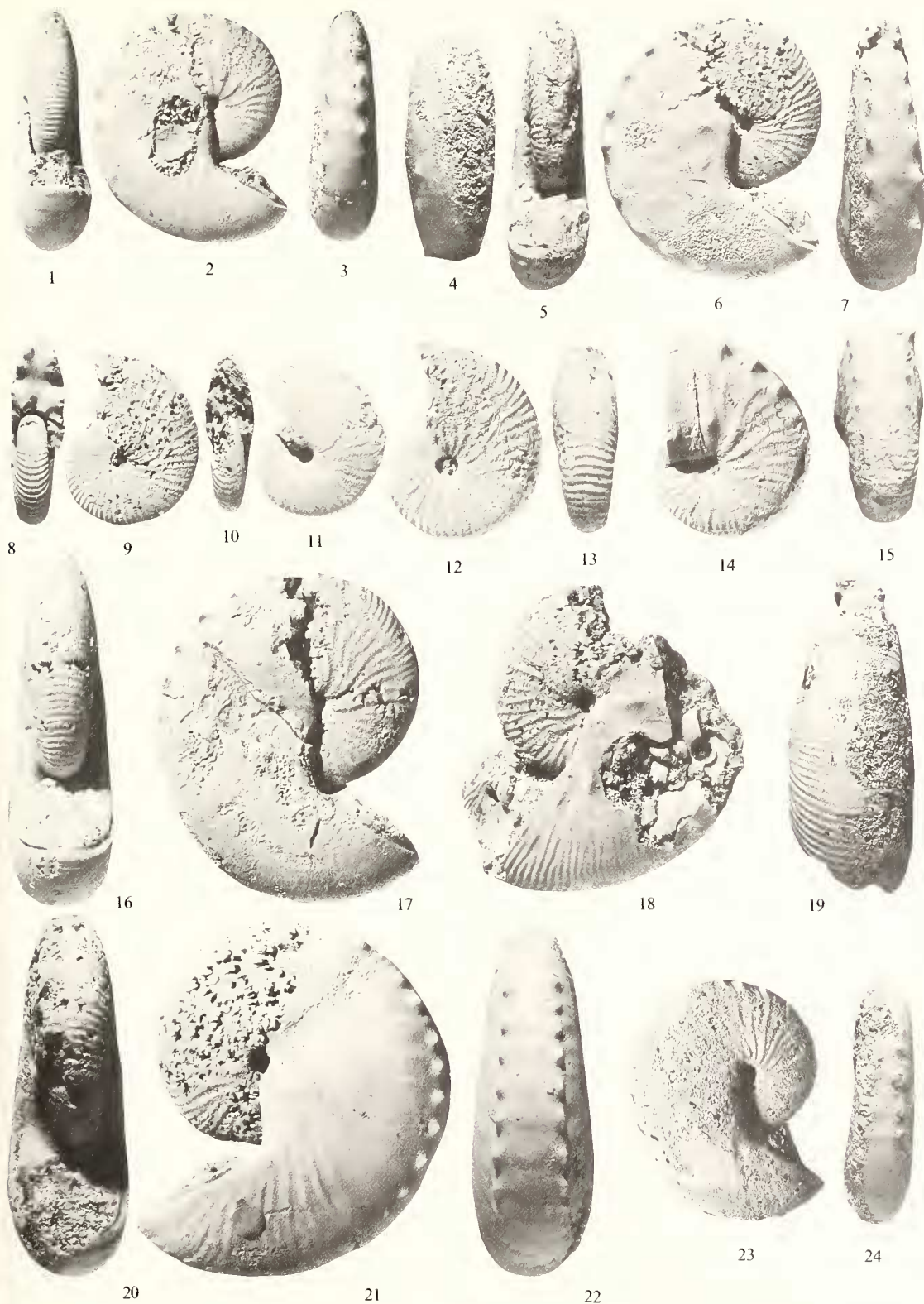
- 1817 *Ammonites constrictus* J. Sowerby, p. 189, pl. A, fig. 1.
- 1837 *Ammonites constrictus* Sow.; Pusch, p. 159, pl. 14, fig. 3.
- 1842 *Scaphites constrictus* d'Orbigny; d'Orbigny, p. 522, pl. 129, figs. 8–11.
- 1848 *Scaphites compressus*, D'Orb.; Kner, p. 10, pl. 1, fig. 4.
- 1850 *Scaphites constrictus* d'Orb.; Alth, p. 207, pl. 10, figs. 29 and 30.
- 1850 *Scaphites constrictus* d'Orb.; d'Orbigny, p. 214.
- 1851 *Ammonites monteionensis* Leymerie, p. 198, pl. 11 (C), figs. 3 and 4.
- 1852 *Scaphites constrictus* d'Orb. var; Kner, p. 300 (8), pl. 15 (1), fig. 13.
- 1858 *Scaphites multinodosus* n. sp. Hauer, p. 9, pl. 1 (2), figs. 7 and 8.

EXPLANATION OF PLATE 13

Figs. 1–13, 16–24. *Hoploscaphites constrictus* (J. Sowerby, 1817). 1–3, MNB unreg. (*ex* de Gerville Collection), a small macroconch, from Orglandes; original of Schlüter (1872, pl. 28, figs. 6–8) 4–9, BMNH C70645 (*ex* J. Sowerby, *ex* de Gerville Collection), paralectotype, from [Ste Colombe] 'near Orglandes', a small macroconch. 10 and 11, EMP 'c' (Deshayes Collection), from Orglandes. 12 and 13, SP 9 unlocalized juvenile macroconch. 16 and 17, MNHP d'Orbigny Collection no. 7194, macroconch from Ste Colombe; probably original of d'Orbigny (1842, pl. 129, figs. 8, 9, ?11). 18 and 19, MNHP unreg., macroconch from Cussy, near Fresville. 20–22, BMNH C36733, lectotype, macroconch from Ste Colombe; original of James Sowerby (1817, pl. A, fig. 1). 23 and 24, SP 10 (*ex* Munier-Chalmas Collection), from Valognes.

Figs. 14 and 15. *Hoploscaphites* sp., SP 13, imprecisely localized.

All from Upper Maastrichtian Calcaire à *Baculites* of Manche, France. All $\times 1$.



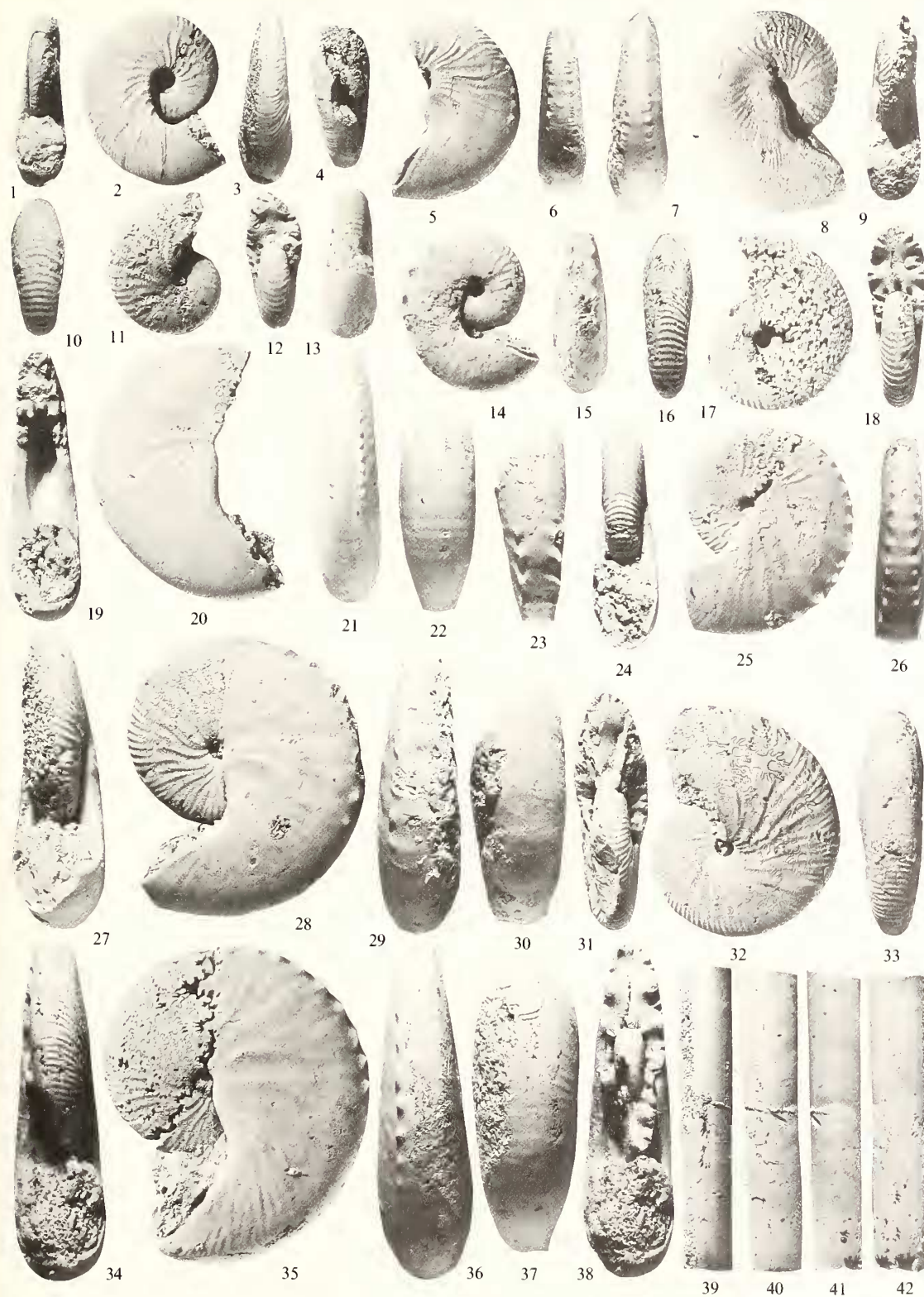
- 1861 *Scaphites constrictus* d'Orbigny; Binkhorst, p. 38, pl. 5d, fig. 6a-h (with synonymy).
 1861 *Scaphites multinodosus* v. Hauer; Gümbel, p. 574.
 1861 *Scaphites* (?) *falcifer* Guemb., Gümbel, p. 574.
 1861 *Scaphites ornatus* Roem.; Gümbel, p. 576.
 1869 *Scaphites constrictus* Sowerby, sp.; Favre, p. 18, pl. 5, figs. 1-4.
 1872 *Scaphites constrictus* Sow. sp.; Schlüter, p. 92, pl. 28, figs. 5-9 (with synonymy).
 non 1873 *Scaphites* spec. indet. cfr. *Scaphites constrictus* Sow.; Redtenbacher, p. 130, pl. 30, fig. 12.
 1885 *Scaphites constrictus* Sowerby sp., Möberg, p. 27, pl. 3, figs. 3-5.
 1891 *Scaphites constrictus* Sow. sp.; Böhm, p. 48, pl. 1, fig. 10a.
 1894 *Scaphites constrictus* Sowerby sp.; de Grossouvre, p. 248, pl. 31, figs. 1, 2, 7, 8.
 1894 *Scaphites niedzwiedzkii* Uhlig, p. 220, text-fig. 2.
 1899 *Scaphites constrictus* Sow.; Semenow, p. 134, pl. 5, fig. 8.
 1902 *Scaphites constrictus* Sowerby, sp.; Ravn, p. 254, pl. 3, fig. 9.
 1907 *Scaphites constrictus* Sow.; Wisniowski, p. 193, pl. 17, fig. 2b.
 1907 *Scaphites constrictus* var. *Niedzwiedzkii* Uhl.; Wisniowski, p. 193, pl. 17, fig. 2a.
 1908 *Scaphites constrictus* Sowerby, sp.; de Grossouvre, p. 36, pl. 11, figs. 3-7.
 1909 *Scaphites constrictus* Sow.; Nowak, p. 773, pl. 1, fig. 1.
 ?1909 *Scaphites* cfr. *Niedzwiedzkii* Uhlig; Böhm in Böhm and Heim, p. 54, pl. 1, fig. 3.
 1911 *Scaphites constrictus* Sow.; Lopuski, pp. 113, 133, pl. 2, figs. 3 and 4.
 1911 *Scaphites constrictus* Sow. var. *crassus* mihi; Lopuski, pp. 115, 134, pl. 2, figs. 5 and 6; pl. 3, figs. 1 and 2.
 1911 *Scaphites* sp. Lopuski, p. 117, pl. 3, fig. 4.
 ?1911 *Scaphites* sp. Lopuski, p. 118, pl. 3, fig. 3.
 1911 *Scaphites* sp. Lopuski, p. 118, pl. 3, fig. 5.
 1911 *Hoploscaphtes constrictus* Sowerby *vulgaris* Nowak, p. 583, ?pl. 32, fig. 6; pl. 33, figs. 8-12.
 1911 *Hoploscaphtes constrictus-tenuistriatus* Kner; Nowak, p. 585, pl. 33, fig. 14 (non 13).
 1915 *Scaphites constrictus* Sowerby; Frech, p. 562 (*pars*), text-figs. 9 and ?10.
 1925 *Discoscaphites constrictus* Sowerby; Diener, p. 210 (with synonymy).
 1932 *Hoploscaphtes constrictus* Sowerby; Wolansky, p. 10, pl. 1, figs. 10 and 12.
 1951 *Discoscaphites constrictus* (Sowerby); Mikhailov, p. 90, pl. 17, figs. 77-80 (with synonymy).
 1951 *Discoscaphites constrictus* (Sow.) var. *niedzwiedzkii* (Uhlig); Mikhailov, p. 93, pl. 15, fig. 65; pl. 17, figs. 81 and 82; pl. 18, fig. 85.
 1959 *Discoscaphites constrictus* (Sowerby); Naidin and Shimanskij, p. 196, pl. 6, figs. 7 and 8.
 1959 *Discoscaphites constrictus* (Sowerby) var. *niedzwiedzkii* (Uhlig); Naidin and Shimanskij, p. 197, pl. 6, figs. 1-4.
 1966 *Scaphites* (*Hoploscaphtes*) *constrictus* (Sowerby); Birkelund, p. 741 et seq.; text-figs. 1, 7, 8.
 1974 *Hoploscaphtes constrictus constrictus* (Sowerby, 1818); Naidin, p. 173, pl. 58, figs. 7-9; pl. 61, figs. 2-4.
 1974 *Hoploscaphtes constrictus niedzwiedzkii* (Uhlig, 1894); Naidin, p. 174, pl. 58, figs. 10 and 11.
 1979 *Hoploscaphtes constrictus* (Sowerby, 1817); Birkelund, p. 55, text-figs. 2 (*pars*), 3d, e.
 1979 *Hoploscaphtes constrictus crassus* (Lopuski, 1911); Birkelund, p. 55.

EXPLANATION OF PLATE 14

Figs. 1-38. *Hoploscaphtes constrictus* (J. Sowerby, 1817). 1-4, MNHP R1247b, microconch from 'région de Ste Colombe'. 5-9, MHNG unreg. (ex Pictet Collection), microconchs from Fresville. 10-12, SP 12, unlocalized juvenile of intermediate inflation. 13-15, EMP unreg., microconch from Fresville; original of de Grossouvre (1894, pl. 31, fig. 2). 16-18, BMNH C70646 (ex J. Sowerby, ex de Gerville Collection), juvenile paralectotype from [Ste Colombe] 'near Valognes'. 19-22, SP 3, macroconch of the compressed form from Fresville. 23-26, EMP 'b', either very large microconch or small macroconch, from Orglandes. 27-30, MNHP R1247c, macroconch from 'région de Ste Colombe'. 31-33, SP 11, unlocalized juvenile macroconch. 34-38, SP 8, macroconch from Néhou.

Figs. 39-42. *Fresvillia constricta* gen. et sp. nov., IRSNB 10254 (ex Leriche Collection, IG 19859), holotype, from Fresville.

All from Upper Maastrichtian Calcaire à *Baculites* of Manche, France. All $\times 1$.



- 1979 *Mesoscaphites grossouvrei* Atabekian, p. 523 (*nom. nud.*).
 1979 *Mesoscaphites kneri* Atabekian, p. 523 (*nom. nud.*).
 1980 *Hoploscaphites constrictus anterior* Blaszkiewicz, p. 36, pl. 17, fig. 5; pl. 18, figs. 4–10.
 1980 *Hoploscaphites constrictus crassus* (Lopuski, 1911); Blaszkiewicz, p. 37, pl. 18, figs. 1–3, 11–14.
 1982 *Hoploscaphites constrictus* (Sowerby, 1818); Birkelund, p. 19, pl. 3, figs. 1–14.
 1982 *Hoploscaphites constrictus constrictus* (Sowerby, 1817); Tsankov, p. 24, pl. 7, figs. 6–8.
 ?1982 *Scaphites* (*Hoploscaphites*) *constrictus* J. Sowerby; Martínez, p. 172, pl. 30, fig. 6.
 1983 *Hoploscaphites constrictus*; Riccardi, p. 9.

Types. Sowerby obviously possessed more than one specimen of *H. constrictus* from Ste Colombe; Crick (1898, p. 12) and Spath (1953, p. 13) referred to BMNH 43988 (Pl. 15, figs. 18–20) as the type and the original of Sowerby's pl. A, fig. 1, but this bears no resemblance to the figure (see text-fig. 9). Instead, as Phillips (1977, p. 90) notes, BMNH C36733 (Pl. 13, figs. 20–22) purchased from Mrs M. Sowerby in 1935 (together with the originals of figs. 2 and 3 on the same plate) bears a close resemblance to the figure. It is herein designated lectotype of the species. BMNH C43988 is a paralectotype, as are C70645–C70647.

Material. Fifty specimens in the BMNH, EMP, FSL, FSM, FSR, MNHG, MNHH, MNB, MNHP, OUM, and SP Collections, including the original of Schlüter (1872, pl. 28, figs. 6–8) (MNB unreg.; Pl. 13, figs. 1–3), d'Orbigny (1842, pl. 129, figs. 8 and 9) (MNHP d'Orbigny Collection no. 7194; Pl. 13, figs. 16 and 17), and de Grossouvre (1894, pl. 31, figs. 1 and 2) (EMP unreg.; Pl. 14, figs. 13–15). Localities mentioned are Manche, Fresville, Orglandes, Ste Colombe, Néhou, Veuville, Chef-du-Pont, Port Filiolet, and Cussy.

Description. Highly variable and strongly dimorphic. Phragmocone very involute with tiny umbilicus. Whorl section varies from compressed (whorl breadth to height ratio down to 0.5) and flat-sided with broadly rounded ventrolateral shoulders and flattened venter (Pl. 13, figs. 8–13; Pl. 14, figs. 1–3, 24–26), to fat with swollen inner flanks, convergent outer flanks, broadly rounded shoulders, and somewhat flattened venter (whorl breadth to

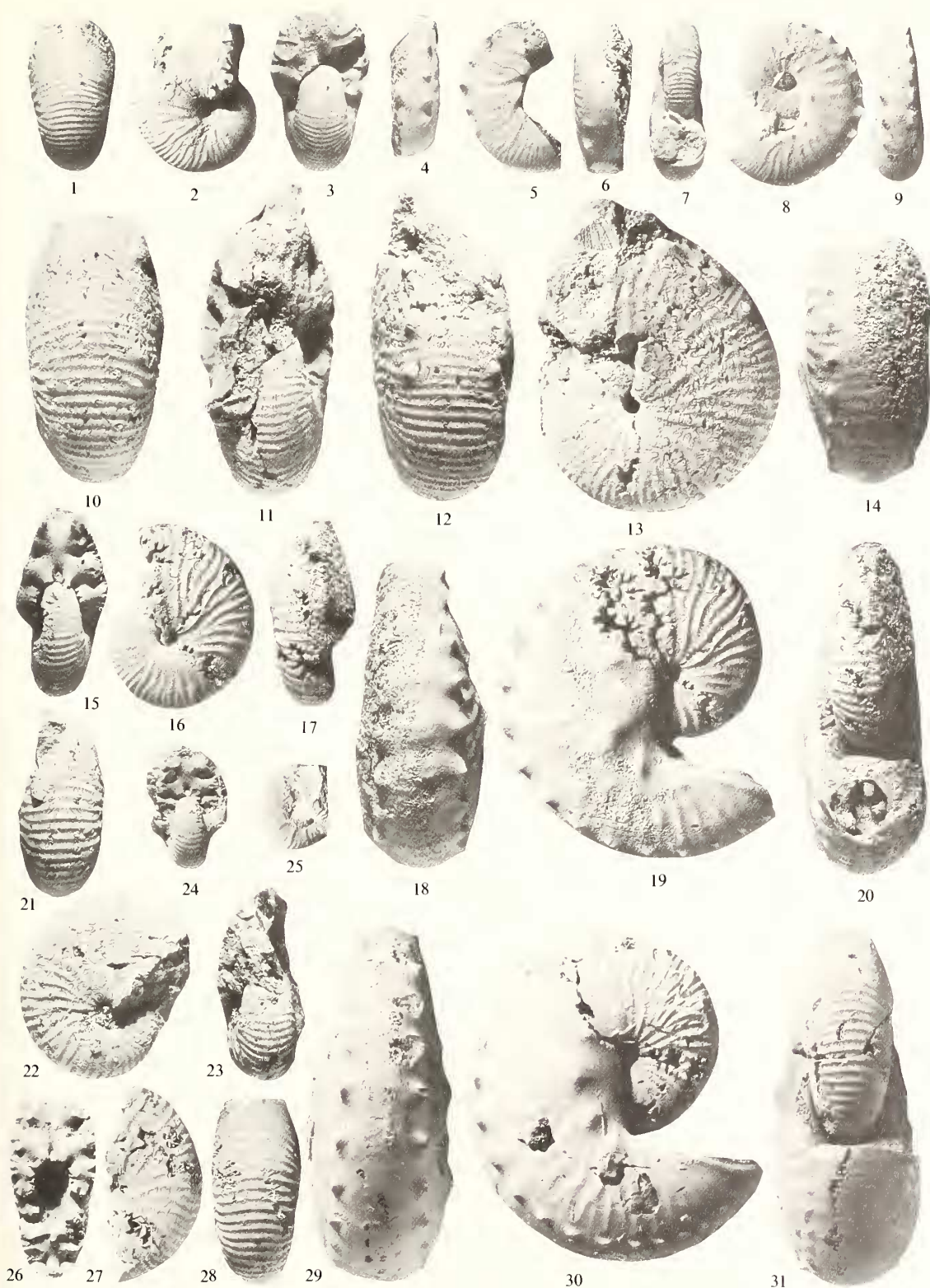


TEXT-FIG. 9. Copy of original illustration of *Ammonites constrictus* J. Sowerby, 1817, pl. A, fig. 1; compare with Plate 13, figs. 20–22.

EXPLANATION OF PLATE 15

Figs. 1–31. *Hoploscaphites constrictus* (J. Sowerby, 1817). 1–3, FSR 1 (?ex Seunes Collection), inflated yet finely ribbed juvenile from Fresville. 4–6, EMP D (ex Deshayes Collection), microconch from Orglandes. 7–9, BMNH C85008, microconch from 200 m south of Fresville Church. 10–13, BMNH C70647 (ex J. Sowerby, ex de Gerville Collection), paralectotype from [Ste Colombe] 'near Valognes', phragmocone of largest macroconch seen. 14–20, BMNH C43988, another paralectotype from same horizon, collection, and locality as BMNH C70647, and corresponding to variety *crassus* of authors. 21–23, SP 6 (ex Leclerc Collection), juvenile macroconch of the stout variety from Néhou. 24–29, MNHP R1272a (ex de Vibraye Collection), stout juvenile macroconch from Ste Colombe. 29–31, EMP unreg., macroconch from Fresville, corresponding to variety *crassus* of authors; original of de Grossouvre (1894, pl. 31, fig. 1) and holotype of *Mesoscaphites grossouvrei* Atabekian, 1979.

All from Upper Maastrichtian Calcaire à *Baculites* of Manche, France. All $\times 1$.



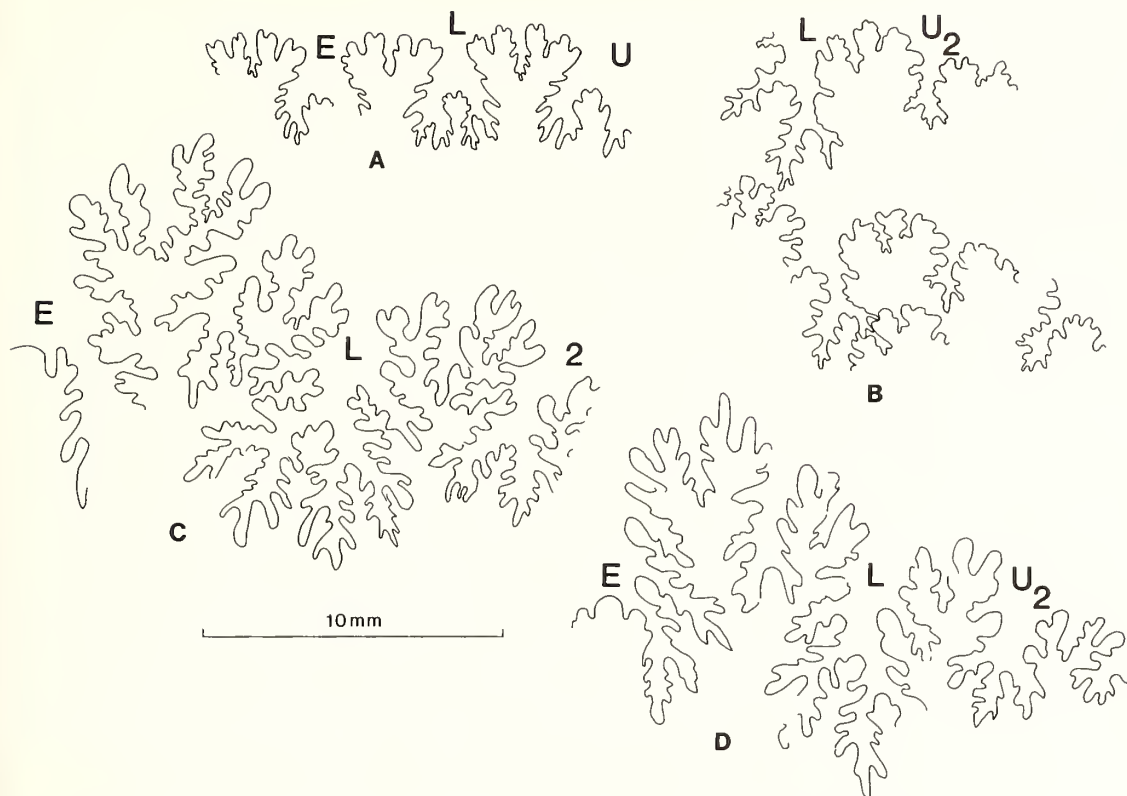
height ratio up to 0.95) (Pl. 15, figs. 1–3, 10–31). Sixteen to twenty primary ribs arise at umbilical seam, are flexuous, vary from feebly concave (Pl. 13, fig. 11; Pl. 15, fig. 16) to straight and prorsiradiate (Pl. 13, fig. 9; Pl. 15, fig. 22) on inner flank, are generally convex at mid-flank, concave on outer flank and ventrolateral shoulder, and feebly convex over venter. They subdivide low on flank, where long intercalatories also arise (e.g. Pl. 15, fig. 19); intercalatories and secondaries branch a second time (e.g. Pl. 13, fig. 12; Pl. 15, fig. 2) on outer flank, where additional short intercalatories also insert, with much variation in style and strength between individuals; from fifty-five (Pl. 15, fig. 16) to around eighty (Pl. 14, fig. 17) ribs on venter per whorl, ribs feebler and more numerous in compressed individuals (Pl. 13, figs. 8–12; Pl. 14, figs. 8, 17, 25, 28, 32, 35) and generally fewer and coarser in more inflated ones (Pl. 15, figs. 16, 19, 22, 28, 30), with a few exceptions (Pl. 15, figs. 2 and 13). Early phragmocone whorls devoid of tubercles. Inflated individuals have up to five pointed ventral tubercles on last part of phragmocone (Pl. 15, fig. 19), with one or two non-tuberculate ribs between and a similar number of tiny nodes on some compressed individuals (Pl. 13, fig. 2; Pl. 14, fig. 25). Other compressed individuals have tiny nodes on every rib over last part of phragmocone (Pl. 14, figs. 1–3); in others they appear lacking (Pl. 14, figs. 7–9, preservation is poor, however). A few specimens show umbilico-lateral or inner lateral bulla or bullae on last part of phragmocone (Pl. 15, figs. 19 and 30).

Body-chambers vary widely. In compressed microconchs (Pl. 15, figs. 1–9) ribbing becomes very flexuous, primary ribs develop sharp bullae at umbilical shoulder, and increase by branching and intercalation gives dense ribs on venter (most or all of which bear tiny tubercles on shaft). Ornament declines on final hook, tubercles disappear, and flanks are ornamented by fine striae only (Pl. 14, figs. 2, 5, 8). Macroconchs of this type are essentially similar (Pl. 14, figs. 19 and 20). These forms grade into bluntly decorated individuals with broader whorl section, like lectotype (a macroconch: Pl. 13, figs. 20–22) where long, low umbilical bullae give rise to groups of ribs that increase by branching and intercalation to link, in groups, to pointed ventrolateral nodes (Pl. 13, fig. 6; Pl. 14, fig. 28) which, in some, elongate into prominent clavi (e.g. Pl. 15, figs. 4–9, microconchs). These specimens lack ventral ribs, unlike more compressed individuals (compare Pl. 14, figs. 3 and 15), and maintain distinct branching and intercalated ribs to aperture, although tubercles decline and are lost on final part of hook. A few specimens of this type (including holotype) develop low swelling between ventral clavi on early part of body-chamber (e.g. Pl. 14, fig. 26). The most inflated body-chambers are decorated by distinct umbilical or inner lateral bullae (Pl. 15, figs. 18–20, 29–31) that may persist to aperture (Pl. 13, fig. 18; Pl. 15, fig. 19), but these are linked by every transition to specimens in which bullae are incipient only (e.g. Pl. 14, fig. 28). Ribs arise in groups from these bullae, branch and intercalate, and loop to ventral clavi which are separated by smooth zones or effacing secondaries and intercalatories (Pl. 15, figs. 19 and 30). In some specimens a distinct siphonal swelling is crossed by fine riblets that loop between ventral clavi (Pl. 15, fig. 18); in others ventral region is virtually smooth between clavi. Ribs and tubercles may decline towards aperture, or persist (Pl. 15, figs. 19 and 31).

Suture lines (text-fig. 11A–H) vary in detail only and are consistently simple and little incised.

Discussion. I can draw no lines between the specimens from the Calcaire à *Baculites*; there appears to be every gradation in whorl compression, ribbing, and tuberculation style. *Scaphites multinodosus* (Hauer, 1858) (p. 9, pl. 1 (2), figs. 7 and 8) from the Maastrichtian of Neuberg, Styria, is a small macroconch of the present species. It occurs with *Pachydiscus neubergicus* (Hauer, 1858) and is significantly older than the present material. (The *S. multinodosus* of Hauer 1866, p. 306, pl. 1, figs. 7 and 8 is a *Trachyscaphites*; *fide* Cobban and Scott 1964.) I agree with Birkelund (1982) and Makowski (1963) that *S. niedzwiedzki* Uhlig, 1894 (p. 220, text-fig. 2) is a microconch of the present species. *H. c. crassus* Lopuski, 1911 (pp. 115, 134, pl. 2, figs. 5 and 6; pl. 3, figs. 1 and 2) can be matched with the coarsely ribbed specimens described here (Pl. 15, figs. 18–20, 29–31) and is inseparable from *constrictus* even at sub-specific level. *H. c. vulgaris* Nowak, 1911 (p. 583, pl. 32, fig. 6?; pl. 33, figs. 8–12) is equally inseparable. *Mesoscaphites grossouvrei* Atabekian, 1979 (p. 523) (*nomen nudum*) has, as holotype, the original of de Grossouvre (1894, pl. 31, fig. 1). This specimen (Pl. 15, figs. 29–31) is merely a coarsely ribbed variant of 'crassus' type and is Upper, rather than Lower Maastrichtian as suggested by Atabekian. '*M.*' *kneri* Atabekian, 1979 (p. 523) (*nomen nudum*) has the original of Kner (1852, pl. 15, fig. 13) as holotype and is also a *constrictus*.

H. c. anterior Blaszkiewicz, 1980 (p. 36, pl. 17, fig. 5; pl. 18, figs. 4–10) from the Lower Maastrichtian of Poland was separated from *H. constrictus sensu stricto* on the basis of a smaller apertural angle (95°), 'not so close contact of body chamber and phragmocone and a smaller degree of flattening of the ventral side' (Blaszkiewicz 1980, p. 36), and a lower stratigraphic position. The

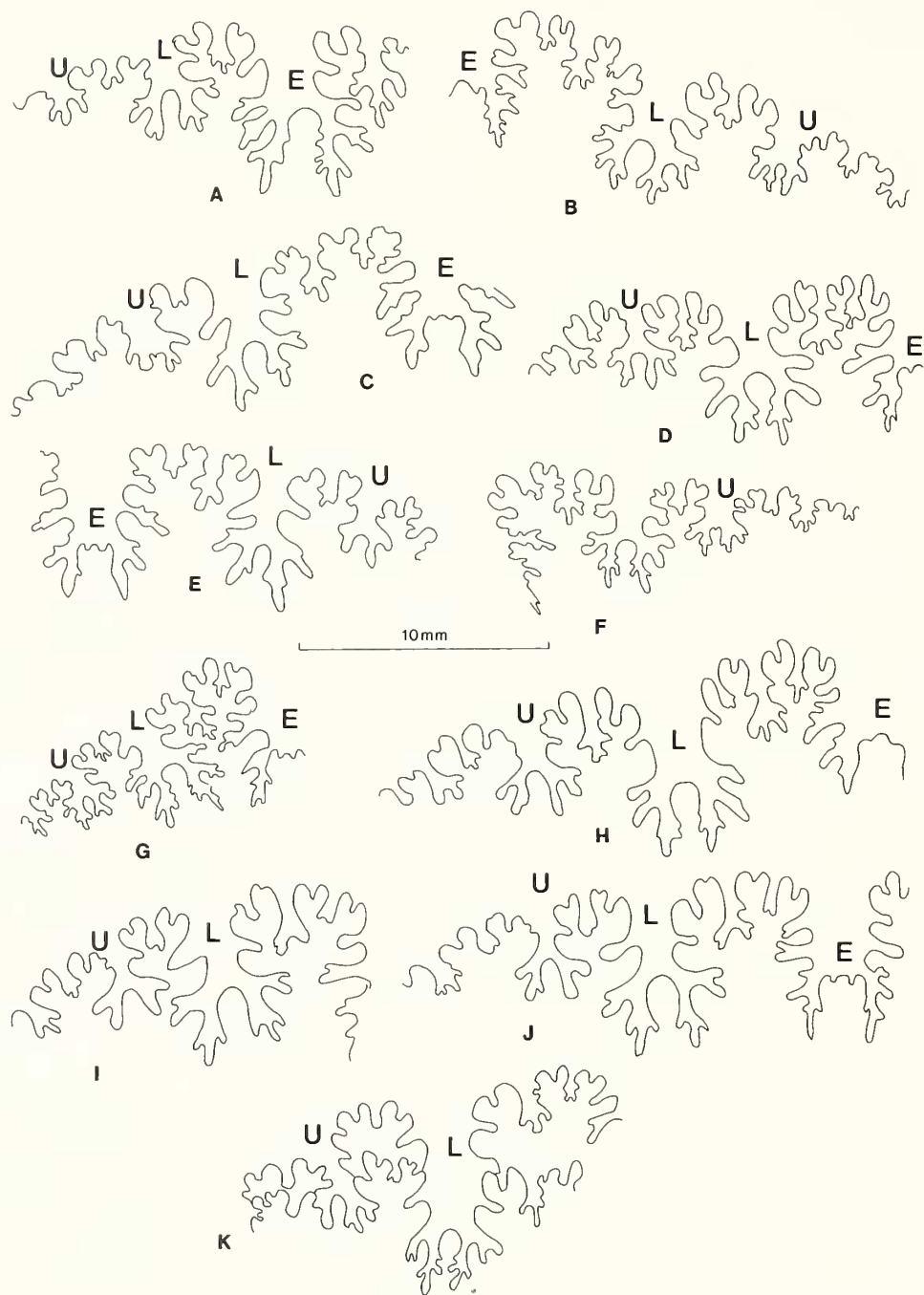


TEXT-FIG. 10. External sutures. A, *Fresvillia constricta* gen. et. sp. nov., IRSNB 10254. B, *Hoplitoplacenticeras lasfresnayianum* (d'Orbigny, 1841), SP unreg. C, *Acanthoscaphites verneuillianus* (d'Orbigny, 1841), EMP unreg. D, *Acanthoscaphites* sp., MNHP R1270.

holotype is no more than a variant of the present species, resembling closely the individual shown in Plate 13, figs. 5–7, and is treated as a synonym.

H. tenuistriatus (Kner, 1848) (p. 10, pl. 1, fig. 5), originally described from Kieselka near Lemberg (now Lvov), characterizes a level well below that of the present material (*vide* Birkelund 1982). It has been treated as a separate species (as by Kner; Favre 1869; Birkelund 1982) or as a subspecies of *constrictus* (as by Nowak 1909, 1911; Wolansky 1932; Naidin 1974). It has a rather coarsely ribbed phragmocone and a very finely ribbed body-chamber lacking nodes. The last two features separate it from *constrictus* and I regard it as specifically distinct, although Nowak (1911, pl. 33, fig. 13) figured what he believed to be *tenuistriatus* with nodes.

Acanthoscaphites schmidt Birkelund, 1982, from the middle of the Maastrichtian at Hemmoor, north-west Germany, seems rather to be a *Hoploscaphites*. The holotype (Birkelund 1982, pl. 1, figs. 7–9) is a microconch which has ventral and weak siphonal tubercles on the phragmocone and early body-chamber, with very fine ribs on the venter and ventrolateral parts of the body-chamber. As described above, some *H. constrictus* develop a feeble siphonal node (e.g. Pl. 15, fig. 18) while some specimens, discussed further below (e.g. Pl. 16, figs. 1–6, 11–14) are very close indeed to Birkelund's species but have a simple, *Hoploscaphites* suture; these may be further variants of *constrictus*, as siphonal tubercles appear more than once in Upper Cretaceous *Scaphites*.



TEXT-FIG. 11. External sutures. A-H, *Hoploscaphites constrictus* (J. Sowerby, 1817). A, G, BMNH C43988; B, SP 8; C, E, SP 9; D, H, SP 11; F, MNHP R1247c. I-K, *Hoploscaphites* sp. 1, J, EMP A; K, SP 13.

Other *Hoploscaphites* species bear little resemblance to the present form and are unlikely to be confused with it.

S. constrictus is held to range from just above the base of the Maastrichtian to the top of the stage, and Birkelund (1979, 1982) has provided the only attempt at recognizing vertical changes in ornament on the basis of material from the Danish Chalk. Forms referred to the 'variety' *crassus*, which occur in the present material, are restricted to the *Belemnella casimirovensis* Zone, while there is a decrease in the number of ribs on the last 10 mm of the body-chamber as one ascends the Maastrichtian, from six (in 'var. *crassus*') to about ten in finer ribbed individuals from the Calcaire à *Baculites* (much as in the Danish *casimirovensis* Zone material).

The range of size in dimorphs of this species was measured by Makowski (1963) who described a collection of thirty-two specimens from the Upper Maastrichtian of Kazimierz on the Vistula. The twenty-two macroconchs (69 %) ranged from 47 to 68 mm; the ten microconchs (31 %) from 22 to 35 mm. Of twenty-three measurable specimens from the Calcaire à *Baculites*, fifteen (65%) are macroconchs ranging from 39 to 56 mm and eight (35%) microconchs, ranging from 25 to 34.5 mm length. The largest complete specimen is the lectotype which has a phragmocone 34.5 mm in diameter. BMNH C70647 (Pl. 15, figs. 10–13) is a complete phragmocone 43 mm in diameter, suggesting a complete shell 70 mm long, so that there is a fair agreement with the Polish material.

Occurrence. The species first appears in the Lower Maastrichtian. At Krons Moor in north Germany the first specimen appears 3.5 m to 5.0 m above the base of the *Belemnella lanceolata* Zone, while in Denmark it ranges to the top of the *B. casimirovensis* Zone (which is, however, incomplete). The most southerly records of the species are in the Upper Maastrichtian of the Petite Pyrénées (France) and northern Spain (Ernst Collection; ? the pre-Pyrénéan region of Lleida; Martínez 1982, p. 172, pl. 30, fig. 6). It occurs at all the Calcaire à *Baculites* localities in the Cotentin, throughout the Nekum and Meersen Chalk in the Maastrichtian type area, and in the Calcaire de Kunraed. It occurs widely in the Germanies, Denmark, southern Sweden, Poland, Austria (Styria), Bulgaria, and the USSR (Carpathians, Donbas region, Transcasbia, Kopet Dag).

Hoploscaphites sp.

Plate 13, figs. 14 and 15; Plate 16, figs. 1–6, 11–14, 18, 19; text-fig. 11i–k

Material. Seven specimens, FSR2 from Orglandes; MNHP 1247 are from the 'région de Ste Colombe'; FSR3 from 'Manche'; EMP 'A' from Orglandes; SP 13 from an unspecified locality; FSM 3 from Chef-du-Pont, Fresville; and MHNG (ex Pictet Collection) from Fresville.

Description. Phragmocone as in *H. constrictus* with crowded branching and intercalated ribs, with up to five ventrolateral tubercles and two umbilical bullae at end of phragmocone (Pl. 16, fig. 4). Body-chamber initially with variable umbilical or umbilicolateral tubercles and low, broad ribs (Pl. 13, fig. 14; Pl. 16, figs. 4, 12, 19), strong ventral clavi (Pl. 13, fig. 15; Pl. 16, figs. 1, 11, 13, 18), and blunt siphonal nodes (Pl. 16, figs. 1, 13, 18). No ventral ribs or riblets. Tubercles lost on last half of body-chamber where ribs weaken (Pl. 16, figs. 14 and 19) or become very fine indeed (Pl. 16, figs. 3, 4, 12).

Suture simple (text-fig. 11i–k), as in *H. constrictus*.

Discussion. I originally thought these specimens to be *Acauthoscaphites*. The suture is very simple, as in *H. constrictus*, while the siphonal node is coarse and blunt. Given the presence of an incipient siphonal node in some *H. constrictus* (e.g. Pl. 15, figs. 18 and 29) the present material is probably no more than a further variant. There is a strong resemblance to *H. schmidi* (Birkelund, 1982) (p. 17, pl. 1, figs. 7–10; pl. 2, figs. 1–4) from the middle Maastrichtian of Hemmoor, north Germany. The holotype, a microconch, is closely similar, but the detail of ventral tubercles and ribs on the phragmocone and the delicate secondary ribs on the body-chamber are distinctive. The large, presumably macroconch fragments referred to *H. schmidi* by Birkelund (1982, pl. 2, figs. 1–4) are far larger than any *H. constrictus* known, suggesting it to be a giant, short-lived stock. The present material thus represents a significantly later parallel departure in ornament from typical *H. constrictus*.

Occurrence. As for material.

Genus ACANTHOSCAPHITES Nowak, 1911

Type species. Scaphites tridens Kner, 1848, p. 10, pl. 2, fig. 1, by the subsequent designation of Diener (1925, p. 205).

Discussion. Review of the genus is deferred pending restudy of the type species.

Occurrence. Upper Campanian(?) and Maastrichtian of western, central, and eastern Europe, and the USSR.

Acanthoscaphites verneuillianus (d'Orbigny, 1841)

Plate 16, figs. 15–17; text-fig. 10c

- 1841 *Ammonites verneuillianus* d'Orbigny, p. 329, pl. 98, figs. 3–5.
 non 1842 *Ammonites nodifer* von Hagenow, p. 565, pl. 9, fig. 19.
 1850 *Ammonites verneuillianus* d'Orbigny; d'Orbigny, p. 212.
 1894 *Scaphites verneuili* d'Orbigny sp.; de Grossouvre, p. 253, pl. 36, fig. 2.
 1925 *Scaphites verneuili* d'Orbigny; Diener, p. 204

Type. d'Orbigny's account indicates that this species was discovered by de Gerville in the 'Craie de Fresville, près de Valognes (Manche)'. There are no specimens of this species in his collections, and the unregistered EMP specimen figured by de Grossouvre (1894, pl. 36, fig. 2) and reillustrated here (Pl. 16, figs. 15–17) I take to be the holotype by monotypy.

Dimensions

	<i>D</i>	<i>Wb</i>	<i>Wh</i>	<i>Wb:Wh</i>	<i>U</i>
Holotype	46.8(100)	— (—)	24.4(52.0)	—	5.4(11.5)
MNHP R1271	57.5(100)	25.6(44.5)	31.8(55.3)		9.5(16.5)

Description. Coiling very involute with tiny, deep umbilicus. Umbilical wall rounded and undercut on internal mould; umbilical shoulder narrowly rounded, flanks broadly rounded, converging to broadly rounded venter. Greatest breadth close to umbilical shoulder, estimated whorl breadth to height ratio 0.78. Eleven narrow, distant primary ribs on outer whorl; these arise at umbilical seam, are feebly concave across umbilical shoulder, and straight and prorsiradiate across flanks. They may give rise to fine secondary ribs on outer flank, while up to six fine intercalated ribs, both single and branching, arise at various points on flank. They are set at an acute angle to succeeding primary rib, as though they were secondaries arising from adapical face of that primary. Secondary ribs pass across venter undiminished, but primary ribs decline markedly in strength across this region. At smallest diameter visible on holotype only primary ribs each bear feeble ventrolateral bulla. These persist, and as size increases ventrolateral tubercles appear first on one, then on two secondary ribs. At same point in development a second tubercle appears on ventrolateral shoulder in inner ventrolateral position. At diameter of approximately 27 mm, rounded siphonal tubercles appear, corresponding in position to ventrolateral tubercles.

Discussion. d'Orbigny's figure is reasonably accurate. Apart from the holotype, described above, there is a second, large specimen, MNHP R1271, from Fresville (*ex de Vibraye Collection*) that may belong here (Pl. 16, figs. 20 and 21). It shows a rather similar ventrolateral ornament at a diameter comparable to that of the holotype, but beyond this the tubercles strengthen, while a mid-lateral bulla appears on the primary ribs (Pl. 16, fig. 21). Unfortunately poor preservation precludes fuller

EXPLANATION OF PLATE 16

Figs. 1–6, 11–14, 18, 19. *Hoploscaphites* sp. 1, 4, 13, EMP 'A' (*ex* Deshayes Collection), from Orglandes. 3, FSM 3, from 'Chef du Pont, Fresville, Orglandes'. 5, 11, 12, MNHP 1247a, from Ste Colombe. 2, 6, 14, FSR 3, from 'Manche'. 18 and 19, FSR 2, from Orglandes.

Figs. 7–10. *Acanthoscaphites* sp., MNHP R12470 (*ex* de Morgan Collection), from Fresville.

Figs. 15–17. *A. verneuillianus* (d'Orbigny, 1841), EMP unreg., holotype, from Fresville.

Figs. 20 and 21. *A. cf. verneuillianus* (d'Orbigny, 1841), MNHP R12471 (*ex* de Vibraye Collection), from Fresville.

All from Upper Maastrichtian Calcaire à *Baculites* of Manche, France. All $\times 1$.



description, but it appears that the specimen bears feeble umbilical and lateral bullae, plus strong inner and outer ventrolateral tubercles from *c.* 50 mm onwards. A third specimen, MNHP R12470, also from Fresville (*ex* Morgan Collection) is shown in Plate 16, figs. 7–10. The inner whorls to 27 mm closely resemble those of the holotype, but beyond this the ribs coarsen markedly (Pl. 16, fig. 8) with primaries separated by a single secondary; all ribs bear outer ventrolateral and siphonal tubercles with occasional intercalated nontuberculate riblets (Pl. 16, fig. 10). These differences from the type suggest the presence of a second species, but with so few specimens, and knowing the range of variation shown by e.g. *H. constrictus*, described above, it is recorded as *Acanthoscaphites* sp.

These small species with multiple tuberculation on the phragmocone are very different from the giant type species, *S. trideus* Kner, 1848, as is revealed by study of the fine specimens (in NHMW and GBA Collections) from Nagorzany, Galicia, which include the originals of Favre (1869), where phragmocones lack tubercles. There are closer similarities to *S. trinodosus* (Kner, 1848) (p. 11, pl. 2, fig. 2) in which there are feeble to obsolete umbilical bullae on nuclei, strengthening on the body-chamber, and ventrolateral and siphonal tubercles on all but the early whorls; the absence of inner ventrolaterals immediately distinguishes it from the present form, however.

'*S.*' *puugens* Binkhorst, 1861 (p. 32, pl. 5a3, fig. 1; see also de Grossouvre 1908, p. 37, pl. 11, figs. 1 and 2) has relatively coarse primary ribs on the flank, all of which bear ventrolateral clavi from an early stage, fine looped and intercalated ventral ribbing, and lacks a siphonal tubercle on the phragmocone.

A. imodosus Naidin, 1974 (p. 178, pl. 62, fig. 1) lacks phragmocone tubercles and is a giant species. *A. bispinosus* Nowak, 1911 (p. 577, pl. 32, figs. 1–3) and *A. quadrispinosus* (Geinitz, 1850) (pl. 7, fig. 2; pl. 8, fig. 2) are both large species and lack multiple tubercles on the phragmocone.

Occurrence. Upper Maastrichtian of the Cotentin.

AGE

That the Calcaire à *Baculites* is Maastrichtian is not disputed. There is, however, no *a priori* reason to assume that the whole sequence belongs to one faunal zone, or that the various outliers are all of the same age. Conversely, the facies of the succession is such that only a short time interval may be represented. There is at present no satisfactory ammonite zonation for the Maastrichtian of north-west Europe and, in consequence, the dating of the succession is most usefully discussed in terms of the 'standard' belemnite succession worked out in the White Chalk sequence (e.g. Christensen 1979, but note that Schulz 1979 has proposed a more refined succession for the Lower Maastrichtian):

Upper Maastrichtian	{ <i>Belemnella casimirovensis</i> <i>Belemnitella junior</i>
Lower Maastrichtian	{ <i>Belemnella occidentalis</i> <i>Belemnella lauceolata</i>

Belemnites occur in the Calcaire à *Baculites*, but I have only found fragments in museum collections. Dr W. K. Christensen (Copenhagen) examined five fragments from Fresville–Orglande in the FSM Collections. On the basis of the Schatzky distance and alveolar angle he concludes them to be a *Belemnitella*, the small fissure angle resembling that of some *B. junior*, a species that ranges through the Upper Maastrichtian.

Echinocorys are valuable stratigraphic indicators in White Chalk successions and are also present in the Calcaire à *Baculites*; I have shown three specimens from Fresville (FSM and SP Collections) to Professor G. Ernst (Berlin), Mr C. J. Wood (London), and Mr N. B. Peake (Norwich) who all agree that they are probably Upper Maastrichtian; Mr Peake also suggests that they are probably *casimirovensis* Zone forms. Bryozoans were dealt with by Voigt (1968); in a letter dated 5 August 1984 Professor Voigt confirmed his view that they indicate an Upper Maastrichtian horizon.

Foram assemblages were last investigated by Hofker (1960) who examined a specimen from Port Filiolet and one from Fresville, concluding that the former came from a slightly higher stratigraphic level than the latter, but that both were Upper Maastrichtian. Hofker particularly drew attention to

similarities with the sequence in the Maastricht area, suggesting a correlation with the sequence between divisions Cr4 and Mb of Uhlenbrock (1912), i.e. Upper Maastrichtian. Following the recent revision of the belemnites of the Maastricht area by Schulz and Schmid (1983) this would place the Port Filiolet and Fresville samples within the *Belemnitella junior* Zone of the lower Upper Maastrichtian.

What is the ammonite evidence? There are so few specimens from some localities that absence of taxa is probably of little significance. What I do find significant is the presence, at all localities, of abundant *Baculites anceps*. De Grossouvre (1901, p. 286) recorded *Baculites* as being abundant at the base of the Carrière de Veauville and ranging to near the top of the sequence. Birkelund (1979) has shown this species to be restricted to the upper Upper Maastrichtian *Belemnella casimirovensis* Zone in the expanded Danish chalk successions, while other Calcaire à *Baculites* species that are restricted to this zone in Denmark are *B. vertebralis* and forms of *S. constrictus* referred to the variety *crassus*. The latter is also confined to the upper part of the *casimirovensis* Zone in Poland (Blaszkiewicz 1980), suggesting that the Calcaire à *Baculites* at localities yielding this form (Ste Colombe, Néhou, Fresville) at least extend to high in the *casimirovensis* Zone. The variety *crassus* also occurs in the upper part of the Meersen Chalk in the Maastricht area, associated with rare *Belemnella casimirovensis* and more frequent *Belemnitella junior*, confirming this dating.

Pachydiscus gollevillensis, *P. jacquoti*, and *Anapachydiscus fresvillensis*, typical Calcaire à *Baculites* species, occur in the Calcaire de Kunraed of Kunraed near Maastricht associated with rare *Baculites anceps*, and abundant *B. vertebralis* (i.e. the reverse of their relative abundance in the Cotentin), numerous *H. constrictus* (none of which correspond to the variety *crassus*), and a number of other species of lesser stratigraphic value (Kennedy 1984b). Drs M. G. Schulz and F. Schmidt tell me that they have seen several *Belemnitella* of the *junior* group from the Calcaire de Kunraed, but as this group ranges through the Upper Maastrichtian, this alone is of limited value. *A. fresvillensis* also occurs in the Nekum Chalk of the Maastricht area. *Belemnitella* of the *junior* group are common in the basal part of the Nekum Chalk and range from low in the Viljlen Chalk to the top of the Meersen Chalk, with, as already noted, *Belemnella casimirovensis* appearing only in the upper part of the Meersen Chalk (Schulz and Schmid 1983). This suggests that the pachydiscids characteristic of the Calcaire à *Baculites* appear in the *junior* Zone and, taken with Hofker's correlation, indicate that the Calcaire à *Baculites* spans the upper part of the *junior* Zone and extends locally into the upper part of the *casimirovensis* Zone.

The evidence from the Danish and Dutch sequences are thus in conflict: the former suggests that the Calcaire à *Baculites* is exclusively within the *casimirovensis* Zone, while the latter suggests that it extends down into the upper part of the *junior* Zone, unless the appearance of rare *Belemnella casimirovensis* in the Maastricht area is significantly later than in the Danish White Chalk succession.

Irrespective of these problems, there seems little doubt that the Calcaire à *Baculites* ammonites indicate an exclusively Upper Maastrichtian date for the sequence, and that locally the sequence extends high into the upper Upper Maastrichtian *Belemnella casimirovensis* Zone. There are no exclusively Lower Maastrichtian ammonites and, among the many scaphitids, no *H. tenuistriatus* (Kner, 1848), a form that straddles the Lower/Upper Maastrichtian boundary in White Chalk successions (Birkelund 1982). *Hoplitoplacenticerus lasfresnayanni*, known from a single specimen, represents a genus known only from the Upper Campanian. It is quite distinct from other species of the genus and is taken to be a late survivor; there is no evidence for the Campanian in the fauna of the unit.

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NOTE ADDED IN PROOF

I have recently discovered five additional belemnite fragments from the Calcaire à *Baculites* in the SP Collections (ex de Gerville Collection). Dr W. K. Christensen tells me that these include unequivocal specimens of the Upper Maastrichtian *Belemnitella junior*.